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ADRENAL CORTICAL TUMORS AND THEIR TREATMENT

A STUDY OF SEVEN OPERATED CASES

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A GROUP of seven consecutive patients who had adrenal cortical tumors and who were operated upon at the Mayo Clinic, at some time during the period from 1924 to 1937, all recovered. Two of these patients were operated upon during the past year. All seven patients presented, in varying degrees, the signs and symptoms referred to as the "adrenal cortical syndrome." In five of the seven patients, the removal of an encapsulated tumor resulted in prompt regression of symptoms. In the other two patients (Cases 2 and 4) the carcinomatous tumor had penetrated the adrenal capsule, and, within a period of 18 months after its removal, the tumor recurred with fatal consequences. Since most adrenal cortical tumors producing the syndrome are relatively malignant, but in the early stages are definitely encapsulated, it is important to make the diagnosis early and to remove the lesion before the cells have penetrated the capsule and invaded adjacent structures. The similarity of the clinical syndrome, produced by an adrenal cortical tumor, to that described by Cushing called "pituitary basophilism" or "Cushing's disease" may lead to the erroneous decision that pituitary basophilism is present.

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In view of the fact that treatment of the latter lesion is entirely dependent on roentgenotherapy, from which, in a very few cases, little more than palliative benefit has been obtained, and in view of the fact that adrenal cortical tumors are frequently the cause of a similar syndrome, and that their removal usually can be readily accomplished, we believe that the adrenal gland should be explored if patients present this syndrome, providing their condition permits.

Symptoms and Signs.—The symptoms produced by a hyperfunctioning tumor of the adrenal cortex depend on the sex and age of the patient at the time the tumor begins to overfunction. Thus the clinical picture observed among men is considerably different from that observed among women. Also,

FIG. 1.—(Case 1): (*a*) Showing normal contour of face without hirsutism or acne. (*b*) Encapsulated Grade 4 carcinoma of the right adrenal gland.

when the disease occurs before puberty the symptoms in either sex are different from those which ensue when the disease occurs after puberty. In general, it may be said that the disease among boys results in precocious puberty of the homologous type; that is, the puberty is premature but essentially normal in other respects.* Among girls, on the other hand, hyperfunctioning tumors of the adrenal cortex produce precocious puberty of the heterologous type, that is, the puberty in these girls is not only premature but masculine in character. For example, the cutaneous distribution of hair is masculine in type, the voice changes, the clitoris may enlarge and resemble a penis, *etc.* (Cases 6 and 7; Figs. 5 and 6). Among children of either sex growth of bone is rapid and premature, so that the bone age exceeds the chronologic age of the patient.

If one is justified in expressing an opinion based upon the five cases re-

* We have been able to find reports in the literature of only 12 proved instances of adrenal cortical tumor in male children. To these might be added the case reported by Mainzer,[2] in which there was pyelographic evidence of adrenal tumor. Owing to the small number of cases, didactic statements regarding symptomatology are scarcely justified. It is significant that puberty did not occur in two of 13 cases; namely, those reported by Guthrie and Emery[3] and by Bertil Josephson.[4]

ported in the literature,[1] adrenal cortical tumors of men result in loss of masculinity and in the appearance of feminine characteristics. The breasts enlarge, the habitus takes on feminine contours, the beard disappears, the testes and penis decrease in size and cease to function as organs of reproduction.

When the disease occurs among young women, as is usual, the secondary sexual characteristics tend to become masculine in character. Thus, the menses cease, the breasts decrease in size (Case 3), a beard appears, the hair of the extremities, abdomen and back increases in amount and its distribution is masculine in type, and the clitoris undergoes hypertrophy.

In addition to changes in the secondary sexual characteristics, there are

FIG. 2.—(Case 3): (*a*) Appearance of patient's face before operation. (*b*) Appearance of patient's face two years after operation.

important and interesting associated symptoms which are somewhat common to all cases, regardless of age or sex. Among these symptoms and signs are a florid complexion (Case 5; Fig. 3*a*), purplish striations of the skin (Fig. 3*b*), acne, hypertension, diabetes (either clinical or latent), osteoporosis, weakness and gain in weight.

Contrary to what might be expected from our knowledge of Addison's disease, there is usually no marked disturbance in metabolism of electrolytes demonstrable by chemical examination of the blood.*

The foregoing brief presentation of the clinical pictures encountered in the study of cases of adrenal cortical tumors corresponds fairly closely to the usual

* In this connection it is interesting that we have had three patients who had hyperplastic adrenal glands who gave evidence of disturbances in metabolism of electrolytes which could not be attributed to other causes. McQuarrie and his colleagues have recently reported another similar case. No tumor of the adrenal gland was found in any of these four cases.

and classic descriptions which have appeared in the literature. Unfortunately for diagnostic purposes, many cases encountered do not conform, or conform only slightly, to these classic patterns. Thus, in one woman who had a right cortical adrenal tumor the only symptom that occurred was amenorrhea (Case 1); in other instances, it would be necessary to stretch the meaning of the term "virilism" almost to the breaking point to make it fit the clinical picture encountered.* As one might expect from theoretic considerations, all cardinal and incidental symptoms vary considerably in different cases depending on the duration of the disease and on the intensity of the pathologic process. Of particular significance is the fact that, in a number of cases, especially among women, the clinical picture has not been one of adrenal virilism, but one of pituitary basophilism in all its essential and incidental details. In the latter disease mentioned, in which the primary disturbance presumably results from a basophilic tumor of the pituitary body, the habitus is not masculine but of the buffalo obesity type; the clitoris does not enlarge and the patient bears only a superficial resemblance to the almost completely masculinized female suffering from adrenal cortical tumor of long standing. The case recently reported by Lukens, Flippin and Thigpen[6] is an excellent example of adrenal cortical tumor masquerading as a basophilic tumor of the pituitary body and the literature contains a number of similar cases in which, unfortunately, after the pituitary body had been treated intensely by roentgenotherapy, the patient died of a metastasizing adrenal cortical tumor.

Differential Diagnosis.—It should not be inferred from the preceding remarks that adrenal cortical tumors and basophilic tumors of the pituitary body are the only lesions capable of producing reversion of sexual characteristics or precocious puberty. For example, hyperplasia of the adrenal cortex (sometimes associated with tumors of the thymus) may produce a clinical picture almost, if not entirely, identical with that seen in cases of pituitary basophilism or adrenal cortical tumor. Furthermore, masculinizing tumors of the ovaries (usually arrhenoblastomata, and very, very rarely granulosa cell tumors) result in hirsutism of the male type, amenorrhea, and hypertrophy of the clitoris. However, such tumors practically never cause diabetes, hypertension, osteoporosis or the other incidental symptoms associated with adrenal cortical tumors. In children, tumors and inflammatory processes in the region of the pineal body and contiguous structures may be associated with sexual and somatic precocity. Finally, there are, in addition, many women who have varying degrees of hirsutism, amenorrhea, hypertension, and obesity for which no adequate basis can be found.

Pituitary Basophilism and Adrenal Cortical Adenoma.—The greatest difficulty in differential diagnosis is encountered in women, owing to the similarity of the symptoms of pituitary basophilism to those of adrenal cortical tumor.

* Variations in the clinical pictures which have occurred in association with adrenal cortical tumors bring to mind the variability of clinical pictures in cases of exophthalmic goiter; the term "adrenal virilism" is no more applicable to some cases of adrenal cortical tumor than is the term "exophthalmic goiter" applicable to cases of exophthalmic goiter in which neither goiter nor exophthalmos is present.

FIG. 3.—(Case 5): (*a*) Appearance of patient's face before (above), and one month after (below), operation. (*b*) Full view of patient. (*c*) Tumor of right adrenal gland which was removed.

The diagnostic problem in dealing with children is somewhat different in character, owing to the fact that pituitary basophilism is predominantly a disease of young women and rarely occurs among children. Wright[7] observed a patient, age 11, who is, to our knowledge, the youngest on record to have had this disease. Pituitary basophilism is a slowly progressive disease, characterized by plethoric obesity which is confined to the face, neck, chest, and abdomen; hirsutism of the masculine type; amenorrhea; purpuric ecchymoses; hypertension; osteoporosis; varying degrees of diabetes and a number of other variable incidental signs and symptoms. In general, the clinical picture is fairly constant; most of the cardinal signs and symptoms described by Cushing are present with the result that most patients who have the disease look very much alike. On the contrary, the clinical picture associated with adrenal cortical tumor is much more variable and the disease usually progresses more rapidly. Among patients who have adrenal cortical tumors the endocrine symptoms may be, as previously mentioned, minimal or even absent. This represents one end of a comparative scale throughout which differing gradations in degree of endocrine disturbance are observed. The other end of the scale is represented by the complete picture of adrenal virilism. In such cases the clitoris is enlarged, the habitus is masculine, interest in the opposite sex ceases and the psychic status tends to become masculine. In the latter type, of which the case reported by Lisser is a good example, and especially when the clitoris is enlarged, the gross features of the malady bear only a superficial resemblance to Cushing's disease. However, in the occasional case in which symptoms of the adrenal cortical syndrome mimic in detail all essential features of Cushing's disease, it is exceedingly difficult and often impossible to make a differential diagnosis. Consequently, every patient thought to have Cushing's disease, regardless of how typical the condition may seem, should be examined with the suspicion that the disease may originate in the adrenal glands.

Laboratory Aids.—Routine laboratory studies have been of little aid to differential diagnosis. Frank[8] has recently reported a very high concentration of estrogenic substance, equal only to that encountered in pregnancy, in the urine from four patients who had adrenal cortical carcinomata. Negative reactions were encountered in specimens of urine from 15 patients who had some symptoms of pituitary basophilism or who had the adrenal cortical syndrome. In this group of 15 patients one had a hypernephroma, one had an adrenal medullary paraganglioma, one had an adrenal cortical adenoma, and one had adrenal hyperplasia. Frank concluded that "it seems likely that adrenal cortical carcinoma alone of adrenal tumors increases the amount of estrogenic substance in the urine to as high as from 1,000 to 10,000 mouse units per liter, with a negative pregnancy test." In two cases of our series this test gave negative results. It would appear, therefore, that a positive Frank test would strongly favor a diagnosis of adrenal cortical carcinoma, but that surgical exploration should not be deferred because of absence of large amounts of estrogenic substance in the urine.

Cahill and his associates[9] have recently emphasized a diagnostic procedure, introduced by Carelli,[10] by which the adrenal glands are delineated in

roentgenograms by injection of air into the perirenal fascial space. Our experience with this procedure has been very limited and we are not in a position to pass judgment on its merits or its limitations. In some of the cases reported in the literature satisfactory visualization of adrenal tumor was obtained when pyelograms were normal. It is interesting to note that in the case reported by Lukens and others, "the residual emphysema from the air injection was an added source of difficulty," during operation.

We feel that in case of doubt the adrenal glands should be explored surgically, provided the clinician is familiar with the early symptoms of acute adrenal insufficiency, and if adequate facilities are at hand for treatment of this emergency should it arise. There are two objections to this viewpoint: First, an appreciable number of patients will be disappointed because no benefit results from the operation; and second, it has been stated that in cases in which advanced symptoms of basophilism are present there is considerable

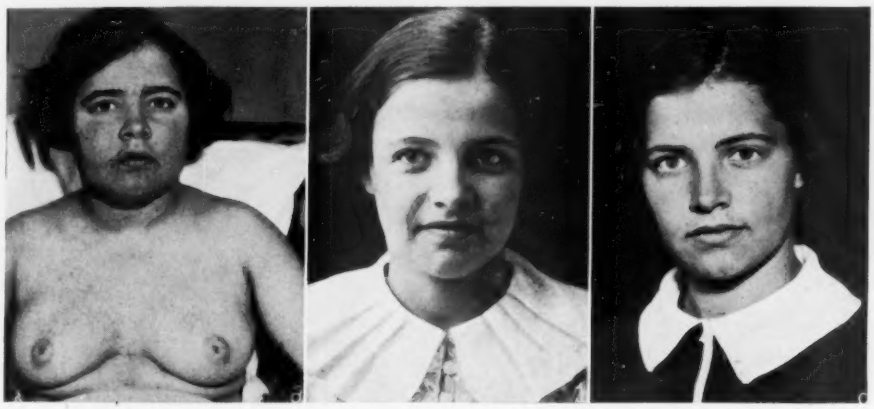

FIG. 4.—(Case 6): (*a*) Appearance of face prior to operation. (*b*) Appearance of face five months after operation. (*c*) Appearance of face three years and ten months after operation.

danger of infection. In our experience this has not interfered with postoperative progress of patients whose adrenal glands were explored without finding cortical tumors; two of these patients were proved to have Cushing's disease by examination at necropsy months after their dismissal from observation. Certainly there is very little justification for the death of patients who receive roentgenotherapy of the pituitary body when the lesion responsible for their symptoms is an adrenal cortical tumor, which might have been eradicated successfully had the patient been operated upon early in the course of the disease.

Surgical Mortality Rate.—Until comparatively recently, the mortality rate following removal of adrenal cortical tumor has been almost prohibitive. Lukens and his associates found that "of forty cases of all tumor types operated upon, nineteen died, although the recent mortality is less than this." The mortality rate in the cases reported is practically 50 per cent, and the chances are that the actual mortality rate is considerably higher because of the natural tendency in isolated instances to report the successes and not the failures. To date eight patients who had adrenal cortical tumors have been operated upon

at the clinic. Except for the first patient in the series, who was operated upon in 1924, before the development of efficient methods of controlling adrenal insufficiency, there have been no operative deaths. As previously stated, two of the patients ultimately died at home, several months after operation, as the result of metastasis. The following factors seem to be responsible for this marked reduction in mortality rate: (1) An increased understanding of the disturbed physiology which follows removal of almost all hyperfunctioning tumors of the endocrine system; (2) an increased knowledge of the pathologic physiology of Addison's disease and, as a consequence, improved methods of treating acute adrenal insufficiency.

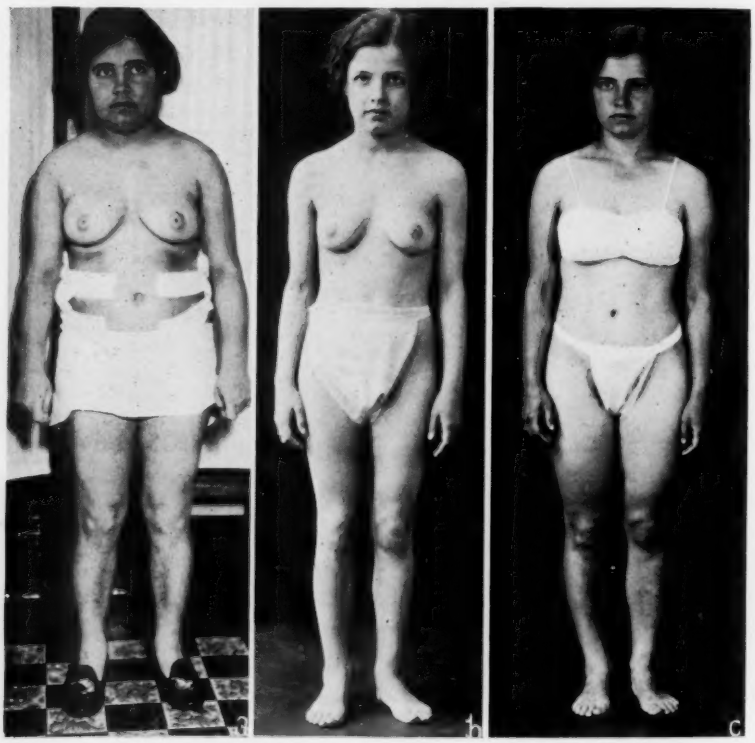

FIG. 5.—(Case 6): (*a*) Habitus of patient before operation. (*b*) Habitus of patient five months after operation. (*c*) Habitus of patient three years and ten months after operation.

Dr. H. S. Plummer was, we believe, one of the first clinicians to call attention to the fact that in cases of single hyperfunctioning adenomata of the thyroid gland, the gland proper, as distinct from the adenoma, functioned very little, or not at all. In other words, he thought that as function of the tumor gradually increased, irrespective of requirements of the body for thyroxin, function of the gland proper, being under the control of the normal regulating mechanism which determined the output of thyroxin, gradually decreased. The same principle seems to apply similarly to hyperfunctioning tumors of other ductless glands. In the case of tumors of the adrenal cortex, this principle is illustrated by the fact that the remaining normal gland is

frequently atrophic or is reduced to a vestigial remnant. Consequently, after removal of such a tumor the remaining gland, which is either atrophic or, at least, functionally inactive, suddenly has thrust upon it the necessity of making sufficient cortical hormone to maintain life.* Not infrequently, this sudden burden proves too great, with the consequence that death occurs after operation owing to acute adrenal insufficiency. If the patient could be carried over the immediate postoperative period, eventually the remaining atrophic adrenal tissue would undergo sufficient hypertrophy to compensate for the loss of its fellow, as it does in experimental studies following removal of five-sixths of all adrenal tissue. We have reasons to believe that such compensatory hypertrophy occurred in at least three patients. In one instance the evidence was unequivocal.

The weight of evidence at present favors the view that the fundamental disturbance in adrenal cortical insufficiency centers around the metabolism of sodium and potassium. This metabolic disturbance is manifested in the plasma by a reduced concentration of sodium and chloride ions and an increased concentration of potassium ions. The other abnormalities in the blood, such as hemoconcentration, retention of nitrogenous products, hypoglycemia, *etc.*, are probably secondary phenomena. All these changes can be rectified by administration of cortical hormone and properly balanced mixtures of sodium salts, chiefly sodium chloride, to which has been added sodium in the form of sodium citrate or sodium bicarbonate. Furthermore, it has been shown that potassium salts are tolerated poorly in cases of adrenal insufficiency, and conversely, that restriction of foods rich in potassium greatly facilitates treatment.

Preoperative and Postoperative Treatment.—With these general principles in mind, the preoperative and postoperative treatment of adrenal cortical tumors is obvious. In brief, postoperative adrenal insufficiency should be anticipated and should be prevented from occurring by continuous treatment throughout the postoperative period, during which time the patient should be watched carefully for any premonitory signs of acute adrenal failure. Among the more important of these signs are anorexia, hiccough, nausea, vomiting, weakness, insomnia, apathy or restlessness, an increasing pulse rate and a falling blood pressure. Pyrexia accelerates the development of adrenal insufficiency and is therefore poorly tolerated. These clinical manifestations may precede any material change in the chemical composition of the blood. The blood pressure should be recorded every four hours and analyses of the blood for its content of sugar, chlorides, and urea should be made daily. If, at any time, the condition of the patient is the least suggestive of adrenal insufficiency, more vigorous treatment is instituted or treatment is resumed if it has been discontinued. It is not generally appreciated

* Analogous phenomena occur following removal of parathyroid tumors and tumors of the islands of Langerhans. In such cases tetany or diabetes may occur postoperatively and subsequently disappear spontaneously. Furthermore, Ingle and Kendall[11] have recently produced experimental atrophy of the adrenal cortex in rats by giving large amounts of the adrenal cortical hormone.

that fatal adrenal failure can develop within a few hours. In consequence of this fact it is easy for the physician to be lulled into a false sense of security. A good rule of thumb to remember is that danger lies in undertreatment rather than in overtreatment.

Abundant administration of solutions of sodium chloride and sodium citrate and daily intravenous and intramuscular injections of cortical hormone are imperative. As soon as a patient is able to retain fluids the salt and ci-

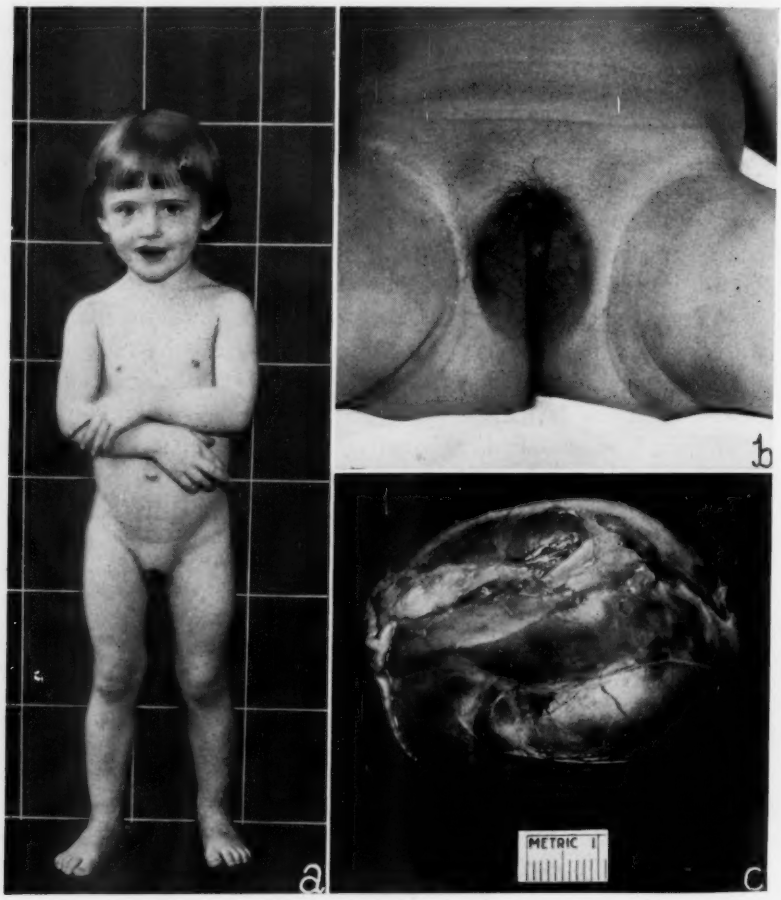

FIG. 6.—(Case 7): (*a*) Appearance of patient prior to operation. (*b*) Appearance of genitalia; note the enlargement of clitoris and precocious growth of hair on labia. (*c*) Tumor of left adrenal.

trate solution is given by mouth and a diet is prescribed which is low in potassium content. The efficacy of this treatment is attested by the fact that since its institution there have been no operative fatalities in seven consecutive cases in spite of the fact that in two instances the adrenal tissue of the opposite gland was found to be atrophic at the time of operation.

Surgical Approach to the Adrenals.—Although transthoracic, transpleural and retroperitoneal approaches to the adrenal gland have been carried out, in our opinion, the approach which gives the best opportunity for minute and

careful inspection of the gland is through a posterolumbar incision similar to that used in exposing the kidney. After the fascia of Gerota has been incised, the perirenal fat is reflected from the upper pole of the kidney and the kidney is retracted downward; this exposes the posterior aspect of the adrenal gland. It is possible in this fashion to study it accurately from every side without disturbing the circulation; care is taken to prevent injury to the blood vessels which enter the adrenal gland on its mesial and inferior aspect. Although we have seen one case of small multiple adenomata, minute in size, in other cases adenomata have been recognized grossly with ease; these have varied in size from 2 to 15 cm. in diameter. When larger tumors are present practically the entire adrenal gland is thinned out and destroyed, with the exception of a fringe a few millimeters in length, which can be recognized by its brilliant yellow color as being adrenal cortical tissue. It must be remembered that on the right side the adrenal gland will be found to be in direct contact with the inferior vena cava. Usually the blood vessels supplying an adrenal tumor are much larger than the blood vessels which supply the normal gland. On this account care must be taken to ligate them accurately.

Report of Cases

Case 1.*—(*Carcinoma of right adrenal cortex: Amenorrhea, lumbar pain, and absence of the other usual endocrine symptoms.*) A married woman, age 33, had had amenorrhea for 18 months; in addition, she had recurring attacks of pain in the right upper abdominal quadrant with chills and fever. Virilism, hirsutism, and paroxysmal hypertension were not present (Fig. 1*a*). On September 26, 1932, a primary adenocarcinoma involving the right adrenal gland (10x8x4 cm.) was removed (Fig. 1*b*). It had a definite capsule. Subsequent to operation the patient was given a course of roentgenotherapy. Three months after operation she had gained 20 pounds (9.0 Kg.) and had had two normal menstrual periods.

The patient returned to the clinic August 13, 1936, for reexamination. She said that she had felt very well since the operation, but that while her periods were regular they were associated with dysmenorrhea and vomiting. She tired rather easily. Examination revealed no evidence of local recurrence of the tumor or distant metastasis.

The patient later reported by letter, November 11, 1937, that she was in good health, and her menstrual cycle was normal with the exception of dysmenorrhea. She had had no abdominal pain and was maintaining her weight.

Case 2.†—(*Penetrating carcinoma of right adrenal cortex; classic symptoms relieved by removal of the carcinoma; recurrence of endocrine symptoms following recurrence of the tumor.*) A married woman, age 25, came to the clinic in August, 1933, because of hirsutism, a gain in weight, acne, weakness, amenorrhea, thirst and polyuria of about three months' duration. (The gain in weight had been of about one year's duration.) She had been examined for life insurance and accepted in December, 1932. Examination revealed that the obesity had largely affected the face, neck and trunk, having spared the extremities. Acne, purplish striae, hirsutism, hypertension (180/120), and slight osteoporosis were noted. There was pyelographic evidence suggesting a right adrenal tumor. At operation, September 12, 1933, a friable adrenal cortical tumor (10x12 cm.) was removed with the exception of a few fragments adherent to the vena cava and to the diaphragm. Pathologic examination showed it to be an adenocarcinoma arising from the right adrenal cortex.

* This case was reported in abstract in the *Proc. Staff Meet. Mayo Clinic*, **8**, 97–110, February 15, 1933.

† Early Reports of this case were published in the *Proc. Staff Meet. Mayo Clinic*, **9**, 169–181, March 21, 1934, and in the Annals of Surgery, **100**, 670–688, October, 1934.

In March, 1934, the patient was reexamined. Practically all stigmata of her disease had disappeared except for a slight acne. The blood pressure was normal and the menses were regular and normal. In May, 1934, the patient again returned to the clinic because all her former symptoms had returned, her menses having ceased in April, 1934. Examination revealed findings almost identical to those noted at the time of the initial examination. The blood pressure was 180/120. A large, hard mass was also present in the right portion of the middle zone of the abdomen. Death occurred in February, 1935, notwithstanding intensive roentgenotherapy.

Case 3.*—(*Encapsulated left adrenal cortical tumor with hirsutism, acne and amenorrhea; cure after three and one-half years following removal of the tumor.*) An unmarried woman, age 39, came to the clinic April 19, 1934. In December, 1933, her menses had ceased. She had gained 13 pounds (5.9 Kg.), and hair had begun to appear on her face, legs and thighs. Her face, hands and legs then became swollen and an intense acneform eruption appeared on the face (Fig. 2*a*). The hair of her scalp began to fall out. Her skin became dry and she became weak. The course of the illness was at first so rapid that acute nephritis was suspected. On examination, a marked, acneform papillary eruption with comedones was noted on the face. The patient was not particularly obese. Her face appeared swollen. Hair was noted on the face, chest, and around the nipples, and on the legs and thighs as well as in the midabdominal region. The breasts were underdeveloped, the clitoris normal. The blood pressure varied from a systolic of 162 to 170 Mm. to a diastolic of 102 to 104 Mm. The glucose tolerance curve was suggestive of latent diabetes. There was slight osteoporosis of the spine. An intravenous urogram disclosed no evidence of an adrenal tumor. Operation was performed April 27, 1934, and an encapsulated tumor of the left adrenal gland, measuring 2.7x2x1.5 cm. and weighing 5.4 Gm., was removed. Microscopic examination revealed an adenocarcinoma of grade 1 (on a basis of 1 to 4).

Following operation the patient appeared to be making an uneventful convalescence and was dismissed from the hospital. Three weeks after the operation she complained of weakness, anorexia and vomiting, and shortly thereafter jaundice and enlargement of the liver developed. Under treatment the jaundice gradually disappeared and the liver could no longer be felt. At the time of the patient's final dismissal, June 27, 1934, her face had largely regained its normal contours, and the comedones had decreased at least one-half in size and number. The blood pressure was 130/76. The patient's strength was improving.

The patient returned to the clinic for reexamination May 25, 1936, at our request. The hirsutism and acne had disappeared and she looked well (Fig. 2*b*). There was no evidence of adrenal insufficiency, although she complained of persisting weakness. Blood pressure 126/86. Five months following operation the patient's menses returned to normal. Pelvic examination showed nothing abnormal. Except for a slight decrease in the value for hemoglobin, nothing abnormal was found on laboratory examination. The patient wrote on November 20, 1937, that her general health was good, although occasionally she felt weak. Her menstrual periods were somewhat painful and profuse. The eruptions on her face and chest had disappeared, as had likewise the coarse, black hair. There was a normal distribution of hair on the arms and legs and the contour of the face was normal.

Case 4.†—(*Extensive penetrating carcinoma of the left adrenal gland with invasion of kidney and adjacent structures; recurrence of tumor and death from metastasis 14*

* Early reports of this case were published in the *Proc. Staff Meet. Mayo Clinic*, **9**, 169-181, March 21, 1934, and in the ANNALS OF SURGERY, **100**, 670-688, October, 1934.

* This case was reported in the *Proc. Staff Meet. Mayo Clinic*, **9**, 400–408, July 3, 1934, and in the ANNALS OF SURGERY, **100**, 670–688, October, 1934.

† This case was reported by Kepler and Priestley in *Arch. f. klin. Chir.*, **5**, 540–563, 1935.

months after operation.) A married woman, age 33, was referred to the clinic November 19, 1934, because of changes in her appearance. Seven and one-half years previously she had given birth to one child and had then elected to have no more. In August, 1934, hair appeared on her face and chest and the pubic escutcheon became masculine in type; her legs and arms had been hairy for a number of years. Simultaneously with the growth of hair, her face became full in contour. She gained eight pounds (3.6 Kg.). The menstrual periods became somewhat irregular but there was no amenorrhea at any time. A reddish rash appeared on the chest.

Blood pressure 150/90. Glucose tolerance curve normal. The clitoris was slightly enlarged. In the left hypochondrium there was a lobulated mass which extended to the level of the umbilicus and halfway over to the midline. A diagnosis of left cortical adrenal tumor was made. Doctor Priestley operated upon the patient November 28, 1934, and found a large tumor adherent to the upper pole of the left kidney; it was also adherent to the diaphragm and adjacent tissue and so friable that the capsule was broken in removing it. The kidney was removed as well. Pathologic examination revealed a tumor 15 cm. in diameter, which was reported to be a hemorrhagic malignant adenoma.

The patient's course subsequent to operation was uneventful. She was given a course of postoperative roentgenotherapy over the left renal area and was dismissed December 15, 1934. Evidence of recurrence of the tumor began in the summer of 1935, and progressed slowly until the left lung was almost wholly involved. Marked enlargement of the liver was noted. The patient died January 4, 1936.

Case 5.*—(*Encapsulated right adrenal cortical tumor with typical syndrome; partial atrophy of the left adrenal gland.*) The patient, age 19, came to the clinic October 12, 1937, because of amenorrhea, pains in the legs, a change in appearance, and weakness. Two years previously she began to have acne. This increased in severity (Fig. 3*a*). Simultaneously she began to gain weight. Fourteen months prior to admission her menstrual periods, which had been normal and regular, suddenly ceased, without hot flushes. Simultaneously, or shortly afterward, it was obvious that the face, trunk and abdomen were becoming larger and that the legs and arms were becoming thinner.

On examination the patient was found to be 65½ inches (166 cm.) in height and weighed 112 pounds (50.6 Kg.). Blood pressure 116/92. The habitus was definitely masculine. The patient's face was full and round and most of the body appeared florid. There was slight obesity of the abdomen. The skin was dry and there were many purplish striations of the hips, abdomen and thighs (Fig. 3*b*). There were also a few striae on both arms below the shoulders. There was definite acne of the face and hirsuitism was present. Although the clitoris was normal, the mons veneris was unusually prominent. Laboratory studies disclosed nothing of consequence. No prolan was demonstrable in the urine by the Frank technic. Nineteen rat units of estrin were found in a 24 hour specimen of urine. A glucose tolerance test was slightly suggestive of a latent diabetes. The value for blood sugar was 98 mg. per 100 cc. before the test; one-half hour later it was 205 mg., two hours later 133 mg., and three hours later 65 mg.

At operation, October 26, 1937, the left adrenal gland was exposed and found to be about one-half to two-thirds the normal size; it was rather brownish in appearance and contained islands of yellow adrenal cortical tissue. A portion 1 cm. in diameter was removed from the lower pole for microscopic examination and was reported normal. The incision in the left side was closed and the right adrenal gland was exposed. It contained a tumor measuring 6x5x2.5 cm. (Fig. 3*c*). It was freed from the inferior vena cava, the pedicle ligated and the tumor removed. Both incisions were closed without drainage. On pathologic examination the tumor was found to weigh 50 Gm.; and was reported to be a cortico-adrenal cytoma (relatively benign).

* Kepler, E. J., Walters, Waltman, and Piper, M. C.: Tumors of the Adrenal Cortex: Diagnosis and Treatment. Case Report. *Proc. Staff. Meet. Mayo Clinic.* (In press.)

The patient's postoperative course was complicated by an increase in temperature and pulse rate. Twenty cubic centimeters of cortin and saline solutions were administered daily. The patient left the hospital November 15. At the time of discharge the high color of the face and extremities was reduced at least 75 per cent. The face was assuming its normal contour and the striations were fading. The excess hair on the face and extremities had not changed materially. The patient wrote on December 28, 1937, that she had begun to menstruate December 27, 1937, and that she was feeling very well. Acneform eruptions were beginning to fade and the hair on her face to disappear.

Case 6.*—(*Encapsulated left adrenal cortical tumor; partial atrophy of right adrenal; premature menstruation and other typical symptoms. No recurrence of symptoms after four years.*) The importance of this case and the excellent result which has been maintained over a period of four years without evidence of recurrence make it worthy of describing again. The patient, a girl, age 9, was referred to the clinic in September, 1933. There was nothing significant in the family history. Birth and development had been normal; she had been healthy until the onset of the difficulty for which she was brought to the clinic. When she was four years of age, her mother had observed the unusual development of her breasts, a generalized growth of hair over her body, and deepening and coarsening of her voice. A year later the pubic hair had become abundant and the external genitalia had developed abnormally. At eight years of age the child had menstruated for four days, and afterward there had been some menstrual spotting at intervals of about two months. The mentality and personality had undergone no great changes, but the child seemed to spend most of her time at home and to shun the company of other children. In her selection of companions she showed no preference for members of either sex. She was in the fifth grade at school and was doing well with her lessons.

On examination the most striking features were: (1) Obesity affecting the trunk, neck and face (Fig. 4*a*); (2) hypertrichosis of the face and body, especially prominent in the axillae and on the mons veneris; (3) purplish, atrophic striations over the abdomen, thighs, and buttocks; (4) precocious development of the breasts and external genitalia; (5) acne of the face and trunk (Fig. 5*a*); (6) a slight elevation of the blood pressure (133/97), and (7) a bone age of 12 years. The outlines of the kidneys in the intravenous urogram were normal.

Surgical exploration was performed October 31, 1933. The right adrenal gland was about one-half the usual size. A section removed for microscopic examination was normal histologically. The position of the left adrenal gland was occupied by a large, encapsulated tumor measuring 6x4x2 cm., a portion of which projected into an enlarged adrenal vein. The tumor was completely removed and was found to be a cortical carcinoma. In three weeks the weight had fallen and the excessive hair was beginning to disappear. Later, the menses ceased, the skin became smooth, the voice became pitched higher, the breasts and external genitalia became smaller, and the other symptoms and signs of the disease gradually disappeared (Figs. 4*b* and 5*b*).

The patient returned at our request for reexamination July 27, 1937. She stated that she had been perfectly well since her last visit in March, 1934. She was then 13 years of age and was to enter high school that fall. She was doing well in school, and taking piano lessons and was reasonably active. Her menses reappeared 22 months after operation and have been regular and normal ever since. Examination July 27, revealed her to be a normal adolescent girl (Figs. 4*c* and 5*c*) with the exception that her breasts were rather large, and contained a considerable amount of adipose tissue. The genitalia were normal but of the adult type. The clitoris had receded in size, and while large, was not huge. The striae in the thighs had bleached out, and the hirsutism and acne had not reappeared. Blood pressure 110/72.

* This case was reported in the *Proc. Staff Meet. Mayo Clinic*, **9**, 169–181, March 21, 1934, and in the ANNALS OF SURGERY, **4**, 678–682, October, 1934.

Case 7.*—(*Encapsulated left adrenal cortical tumor with somatic and sexual precocity and menstrual bleeding.*) A girl, age 23 months, was referred to the clinic by Dr. R. K. Dixon of Denver, Colorado, who had made a diagnosis of probable adrenal cortical tumor. She had been delivered at full term by cesarean section. Her mother said that she had always seemed to be somewhat mentally precocious. At 18 months she had begun to show precocious physical development. She fed herself, went to bed alone and acted like a child of four or five years. At the same time it was noted that the labia and clitoris were becoming larger and that black hair was appearing on the labia majora. The child began to grow rapidly, her shoulders broadened, and she increased in height. At 23 months she was able to exchange dresses with her sister, then age five years, although the sister's clothes had to be shortened somewhat. It was then noted that the patient's hands were about as large as her sister's. On December 12, 1936, there was marked vaginal bleeding, lasting one day. The patient was then 19 months old. For six weeks prior to admission a little acne had been noted on the forehead, and a few weeks prior to admission the child had developed a sense of modesty and had objected to being nude at home or in the examining room and insisted on going to the bathroom alone.

On examination the child was found to be 37 inches (94 cm.) in height and weighed 30 pounds (13.6 Kg.). She appeared definitely larger and heavier than a normal girl of her age (Fig. 6*a*). Blood pressure 116/70. The labia majora and minora were well developed. Hair was present on the labia and there was a definite disproportionate enlargement of the clitoris (Fig. 6*b*). There were no laboratory findings of significance except that roentgenograms of the extremities showed the bone age to be approximately five years. There was no sugar in the urine. The urine was assayed for prolan and estrin, with entirely negative results. A portion of the adrenal cortical tumor was extracted for estrogenic substances but none was found.

On March 23, 1937, a tumor weighing 45 Gm. and measuring 5.5x4.5x4 cm. was removed from the left adrenal gland (Fig. 6*c*). The postoperative convalescence was uneventful and the patient left the hospital on the tenth day postoperative.

On July 13, 1937, she was reexamined by Doctor Dixon and found to be in excellent condition. She then weighed 30 pounds and was 38 inches in height. The pubic hair had changed very little. There had been no further suggestion of menstrual bleeding. It was observed that the child did not eat as heartily as she had before operation.

SUMMARY.—Seven consecutive cases of adrenal cortical tumor, in which recovery has occurred following removal of the tumor, are analyzed as a basis for discussing problems associated with this lesion. Symptoms produced by a tumor of the adrenal cortex depend on the sex and age of the patient at the time the tumor begins to function. These tumors are encountered most frequently among women and are characterized by variable changes in secondary sexual characteristics, such as cessation of menstruation, occasionally hypertrophy of the clitoris, abnormal growth of hair with masculine distribution and characteristic lesions of the skin such as a florid complexion accompanied by acne and purplish striations. Among girls, tumors of the adrenal cortex tend to produce precocious puberty, more masculine than feminine in character. The disease seldom occurs among males, either young or old. The difficulty in making a diagnosis arises from the fact that the clinical picture is not pathognomonic. Similar clinical pictures may result from any

* Kepler, I. J., Walters, Waltman, and Dixon, R. K.: Menstruation in a Child Nineteen Months Old. Result of a Tumor of the Left Adrenal Cortex: Successful Surgical Treatment. *Proc. Staff Meet. Mayo Clinic.* (In press.)

one of a number of diversified pathologic processes, such as: Hyperplasia of the adrenal cortices with or without thymic tumors with tumors of the gonads, and various intracranial lesions not directly involving the pituitary body.

Routine laboratory studies have been of little aid in differential diagnosis although the presence of a high content of estrogenic substance in the urine is suggestive of the presence of adrenal cortical carcinoma provided pregnancy is excluded. Injection of air about the adrenal gland has been of aid in localizing some of the adrenal tumors. In 40 cases reported in the literature the surgical mortality rate was approximately 50 per cent. It is our opinion that the absence of mortality in seven consecutive cases in which operation was performed at the Mayo Clinic is attributable to an increased understanding of the disturbance of physiologic processes which follows removal of almost all hyperfunctioning tumors of the endocrine system, and to an increased knowledge of the pathologic physiology of Addison's disease; improved methods of treating acute adrenal insufficiency have thereby been developed. These consist primarily of administration of large quantities of sodium chloride and sodium citrate, daily administration of an adequate amount of cortical hormone, and a low potassium diet, throughout the entire postoperative period. In our experience, the most accurate surgical approach to the adrenal glands has been through retroperitoneal and posterolumbar incisions.

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DISCUSSION.—DR. MIMS GAGE (New Orleans, La.)—I wish to congratulate Doctor Walters for presenting this interesting subject, and giving us a method by which we can differentiate the basophilic tumors of the pituitary from the cortical tumors of the adrenal. However, this differentiation becomes increasingly difficult when one is confronted with the arrhenoblastoma occurring in the female. As Doctor Walters has stated, every method of precision, both biochemical and physical, should be exhausted before one confirms a tentative diagnosis. At times exploration becomes absolutely necessary in order to settle the confused picture.

In order to prevent the occurrence of fatalities following the removal of cortical tumors of the adrenal gland we should employ the methods of preoperative preparation and postoperative treatment as outlined by Doctor Walters. Failure to supply one of our cases with cortical hormone immediately after operation resulted in a fatality. This patient developed marked hypo-adrenalism before the hormone therapy was instituted. I believe the fatality could have been prevented if the hormone had been given immediately after operation as suggested by Doctor Walters.

DR. LOYAL DAVIS (Chicago, Ill.).—I should like to ask Doctor Walters to emphasize once again the differentiation between the cases which he has presented and those suprarenal tumors which are associated with paroxysmal hypertension. We have recently seen a patient with the latter condition but unfortunately we did not have the opportunity to verify it either at operation or at autopsy.

I should like to bring up another point which is in relation to the symptoms of sexual hypertrophy which Doctor Walters found in his one young male patient, in which he felt there was some disturbance in the region of the pineal gland. Recently we have been able to remove the pineal gland experimentally in kittens, six weeks old, by the use of the Horsley-Clarke stereotaxic instrument. With this instrument any desired point within the brain or brain stem of an animal may be reached and the lesion may be produced by electrolysis. Such animals, without the pineal gland, and this applies particularly to the males, show a very rapid onset of maturity. There are an increase in their weight and a change in their physical appearance as well as in their external genitalia. As far as we know this is the first time that such definite changes have been produced in animals this high in the mammalian scale.

DR. ERNEST SACHS (St. Louis, Mo.).—I would like to record a case bearing on the point that Doctor Davis has just brought up, namely, intermittent hypertension. We had a patient with a diagnosis of a suprarenal tumor, but she had none of the other characteristics of these cases as shown by Doctor Walters. She did have a choked disk; and finally we were able to remove a tumor from the occipital lobe, after which the hypertension diminished. It has been pointed out before that tumors far back in the hemisphere do have hypertension associated with them, and that is another thing that may have to be considered in some of these cases.

DR. WALTMAN WALTERS (closing).—I was very glad to have Doctors Gage and Davis, and Doctor Sachs discuss my paper, because the relationship of intracranial lesions to this syndrome is, I think, one of the very difficult things we have to eliminate. It is easy to explore the suprarenal glands, and it can be done with safety, but, on the other hand, the relationship of intra-

cranial lesions to the syndrome is still obscure. Doctor Davis' interesting experiments should help to clarify some of these problems.

Both Doctor Davis and Doctor Sachs have referred to cases of suprarenal tumors in which paroxysmal hypertension was present. Suprarenal tumors producing paroxysmal hypertension take their origin from the medullary portion of the gland, which embryologically is derived from the same structures as the sympathetic nervous system. This probably accounts for the predominant symptom of paroxysmal hypertension in these cases, in contrast to the symptoms of precocious puberty, virilism, *etc.*, associated with the tumors of the suprarenal cortex, the cortex embryologically taking its origin from tissue giving rise not only to the suprarenal cortex but to the testes and ovaries.

Doctor Toland has asked me to what one can attribute the great decrease in the mortality rate following operations for tumors of the suprarenal cortex. The explanation for this, I think, is largely that we have extracts of the suprarenal cortex which can be administered to the patients both prior to and subsequent to operation, and recognition that certain electrolytes, such as sodium, are lacking in patients who have insufficiency of the suprarenal cortex. The importance, therefore, of seeing that an abundant amount of sodium is administered, both as sodium chloride and sodium citrate, to these patients, has been emphasized in our paper. Of particular importance is the necessity of keeping the patient from whom a suprarenal cortical tumor has been removed under the closest supervision not only during the first few hours after operation but every hour until his complete recovery. It is not generally understood that insufficiency of the suprarenal cortex may occur within eight hours, and may at first be so mild in its clinical characteristics that it may escape detection until a true insufficiency of the suprarenal cortex is present. When such occurs, the "set-up" is not unlike that of the so-called irreversible reaction in cases of diabetic coma, in which, although the acidosis and the hypoglycemia are adequately controlled, the patients continue on to their demise. That these factors are important is evidenced by the progress of the last patient I operated upon, a woman, age 19. We first explored her left suprarenal gland and found it to be only about one-half to two-thirds the normal size. There was so little yellow cortical tissue present that the gland was a brown, mottled yellow as a result of islands of cortical tissue. The tumor on the right side, which measured 6x5x2.5 cm., involved the entire gland. After the removal of the tumor it was apparent that there was marked atrophy of the left suprarenal gland and marked diminution in the substance of the suprarenal cortex. Vigorous treatment with extract of the suprarenal cortex and a solution of sodium administered intravenously as well as sodium citrate administered by mouth prevented any evidence of insufficiency of the suprarenal cortex. Of almost equal importance is the necessity of a low dietary intake of potassium, in the prevention of acute adrenal insufficiency.

THE SURGICAL PROBLEM OF HYPERTENSION

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BASED upon the assumption that removal of the sympathetic supply in cases of Raynaud's disease results in a permanent dilatation of the blood vessels of an extremity, Rowntree and Adson[1] applied the same surgical principle to the treatment of patients with essential hypertension.

Lack of complete knowledge of anatomic and physiologic facts concerning the sympathetic nervous system makes it difficult to evaluate the results of surgical intervention. In several instances in the past, the indiscriminate clinical employment of operations upon the sympathetic nervous system has eventually proven to have been a mistake, and has retarded the acceptance of other procedures logical in their conception and successful in their application.

There can be no doubt that any surgical procedure which offers relief to patients with essential hypertension, for many of whom medical treatment admittedly offers no hope, is welcome. But, when evaluating that surgical procedure all of the severe criteria applied to an experimental physiologic investigation must be employed.

The first problem is to define "essential hypertension," a term which betrays a general ignorance concerning the clinical syndrome to which it is applied.

According to our own views, essential hypertension is a disorder with one or more etiologic factors, in which the blood pressure is over 160 Mm. systolic and 90 Mm. diastolic; with exacerbations and remissions which ultimately result in pathologic changes in one or more parts of the cardiovascular-renal system, notably arteriosclerosis, cardiac hypertrophy, nephrosclerosis and ocular vessel disease. The degree and speed of the development of these changes depend somewhat upon the age of the patient and the height of the blood pressure; the younger the patient and the higher the blood pressure, the more rapidly progressive is the associated vascular disease.

Experimentally, hypertension has been produced in four ways:

(1) Heymans[2] and his coworkers have produced a rapid and permanent rise in blood pressure by removal of the carotid sinus and the cardio-aortic moderator nerves. This type of hypertension may be prevented or decreased only by a complete sympathectomy; section of the splanchnic nerves, lumbar ganglionated chain or adrenalectomy have only a transient effect. This experimental type of hypertension may be similar to the few clinical cases observed with extremely labile blood pressures, but does not correspond with the more common type of clinical hypertension.

(2) Goldblatt[3] has recently succeeded in producing severe grades of hypertension lasting months and years by reducing the caliber of the main renal arteries by the application of an adjustable silver clamp. The resultant renal ischemia due to persistent reduction of blood flow in the kidneys has been uniformly successful in establishing an experimental hypertensive state.

Goldblatt has shown that after the development of hypertension by this method, release or removal of the clamps is followed after a variable period by return of the blood pressure to the original level. Unilateral application of the clamp is followed by elevation of blood pressure over a considerable interval, but if the clamped kidney is removed the blood pressure returns to normal. Clamping the artery of the remaining single kidney will again elevate the blood pressure. The complete occlusion of both renal arteries is followed by a severe uremia, but by only a moderate elevation of blood pressure. Denervation of the renal pedicles does not interfere with the development of experimental hypertension produced in this manner and Goldblatt has shown, further, that section of the splanchnic nerves above the diaphragm, combined with excision of the lower four thoracic sympathetic ganglia, does not materially reduce the systolic blood pressure. Likewise, he has shown that section of the anterior roots from the sixth dorsal to the second lumbar, inclusive, does not interfere with the development of, nor does it permanently reduce hypertension produced in this manner by renal ischemia. To complete the investigation, Freeman and Page[4] have shown that total sympathectomy does not interfere with experimental hypertension produced by renal ischemia—an important difference between this and the type of hypertension experimentally produced by Heymans.

But Goldblatt has also shown that if the adrenal veins are clamped simultaneously with partial occlusion of the renal arteries, hypertension does not develop. Further, hypertension develops if only a small portion of the adrenal cortex is left, sufficient to keep the animal alive.

It is suggested, therefore, that in hypertension due to renal ischemia, an "effective substance" is formed in the ischemic kidney. As Goldblatt states, this renal substance may not act directly by itself but may sensitize the contractile elements of arterioles to the action of a pressor hormone generated elsewhere. Or, it may sensitize other organs so that the natural metabolic processes such as occur in the liver, for example, are interfered with. That the hypophysis must be given some consideration in this mechanism is attested by the experiments of Page[5] who has shown that hypophysectomy does not prevent the experimental hypertension due to renal ischemia but that it does reduce permanently the blood pressure in animals with this type of hypertension.

These experiments have been amply corroborated and Harrison, Blalock and Mason,[6] and Prinzmetal and Friedman[7] have presented evidence to show that extracts of ischemic kidneys contain a greater amount of pressor substances than normal kidneys but whether these substances are the cause of this type of experimental hypertension is not known.

(3) Experimental hypertension can be produced by ligation of the carotid, vertebral and spinal arteries. The resulting cerebral ischemia produces a permanent rise in blood pressure, due probably to anoxemia of the vasopressor centers.

(4) Finally, it has been shown that the administration of vitamin D results in elevation of the blood pressure. In rabbits, an arteriosclerosis is produced which can be duplicated in dogs by performing a thyroidectomy and feeding vitamin D.

Which of these experimental types of hypertension are analogous with essential hypertension in man? Or, are all of these factors involved in a given case? The failure of response to the "carotid sinus" type of hypertension to any operation except total sympathectomy and the failure of the "renal ischemic" type to respond to total sympathectomy must be rationalized. Thus far, the interpretation of these experiments seems to show that removal of the vasoconstrictor sympathetic supply to the vessels of the splanchnic area, theoretically producing a reservoir of dilated vessels, does not prevent or reduce the "renal ischemic" type of experimental hypertension. In other words, the important factor concerns the reduction of blood flow to a functioning kidney and not the general vasomotor mechanism of the abdominal viscera.

As is often the case, these results cannot be transferred directly to the problem of hypertension in man because in a great many cases there is no narrowing of the larger vessels due to arteriosclerosis which would so effectively narrow the lumen of the renal arteries. But one of the constant pathologic findings in essential hypertension is a narrowing of the arterioles of the kidney. Thus, it is conceivable that an improvement of the circulation of the functioning parts of the kidney by dilating the arterioles might result from removal of the vasoconstrictor mechanism.

Clinically, the criteria for classifying patients as cases of essential hypertension vary considerably among various groups of workers. Yet, before surgical procedures can be evaluated, agreement must be reached as to exactly which type of patient is being operated upon, or should be operated upon. Not all will agree with the statement of one group that 85 per cent of all patients with a high systolic blood pressure belong to the primary, or essential, type of hypertension for which no etiologic factor can be found. Again, should the patient with a tumor of the adrenal gland, with a basophilic adenoma of the hypophysis, with chronic glomerular nephritis, with a carotid sinus disorder, or with hyperthyroidism be admitted to this group by reason of a high blood pressure?

There is agreement that the clinical course of a young adult with essential hypertension may be an intense progression to a fatal termination within two years; that is, uremia and death cannot be stayed by medical treatment. On the other hand, a variable hypertension of mild degree may exist in adults under 35 years of age, which represents vasomotor instability and either requires no treatment, or is controlled by simple medical measures. Late in life, a high systolic blood pressure with a normal, or nearly normal diastolic pressure,

related to sclerosis of the large vessels of the body, is relatively unimportant and does not require treatment.

It is agreed, also, that about 90 per cent of the mild cases of hypertension at all ages either have no symptoms or are easily relieved. Of the cases of moderately increased blood pressure, 75 per cent either have no symptoms or can be relieved. Of the severe group over 45 years of age, many have reached a late stage in the disease after a long course. Under medical treatment, at least 30 per cent of these patients may obtain a substantial fall in their blood pressure and another 40 per cent may obtain symptomatic relief over long periods of time. The remaining 30 per cent in this group have marked and irreversible vascular changes, which make amelioration of their symptoms impossible. We are confronted, then, with the group of young adults with malignant progression of their symptoms of hypertension and those patients with a moderate hypertension under 45 years of age for whom surgical intervention may hold hope.

Our experience has not given us a clear picture of differentiation between the "essential" and the so-called "malignant" phases of the disease. To us, malignant hypertension is denoted by that fulminating endothelial necrotic state which may develop at any time in any hypertensive patient; which usually rushes him through to an early death with evidences of widespread destruction of the vessels in the kidneys, retinae and brain. We have seen such changes come on suddenly in patients with severe essential hypertension resulting in terrific headaches, stupor, motor phenomena, cardiac gallop-rhythm, hemorrhages from the nose and urinary tract and actual rupture of the retinal vessels. Such a fulminating episode may be as dramatic as a fatal lobar pneumonia. However, some of the malignant cases may go on for months with periods of exacerbation and remission. Rarely, such a patient may be much improved for a long time after a coronary occlusion or a cerebral vascular accident. We have also seen a reversal from the malignant to the essential type by reducing the blood pressure and controlling it by the administration of cyanates.[8] This type of reversal in the phases of the hypertensive state should cause us to consider carefully surgical treatment.

At which stage in the disease is surgery contraindicated and what constitutes the basic factors for such contraindications? Is it fair to require that the surgical treatment of essential hypertension be evaluated according to its effectiveness in various types and degrees of severity of the disease and the sole criterion be the effect upon the systolic blood pressure? If so, by what standards can the types and degree of severity of the disease be so classified that the results of surgical therapy in one clinic may be compared with another? We suspect that many of the favorable surgical results reported thus far might be duplicated by another group of workers through medical measures alone. However, operations have been performed upon patients who might be considered by other workers as wholly unsuited for surgery. Is the systolic blood pressure the most important factor upon which to judge the effect obtained? We admit, with others, that the lowering of the diastolic pressure is a far more

significant result relative to the patient's welfare. Finally, by what train of physiologic events is the blood pressure reduced following operation?

Several surgical procedures have been proposed for the reduction of hypertension and several tests are now being used to determine if possible which patients may be expected to give a satisfactory result. All of these tests and the operative procedures are based on the assumption that the vasoconstrictor innervation and control of the blood vessels of the splanchnic area, or of the kidney alone, can be removed.

The surgical procedures employed have been several and varied. A bilateral lumbar ganglionectomy and trunk resection proved ineffective because only the vessels of the lower extremities were dilated. Section of the anterior roots between the sixth thoracic and second lumbar segments, inclusive, interrupts all of the efferent sympathetic vasoconstrictor fibers to the kidneys, adrenals, and in addition creates a large reservoir of dilated vessels in the splanchnic vascular area, but the magnitude of the operation and the occasional resulting spinal cord lesions have discouraged its use. Another surgical procedure is directed to the bilateral supradiaphragmatic section of the splanchnic nerves designed to remove the vasoconstrictor fibers from the renal vessels, but the basis for this operation rests upon electrical stimulation experiments alone. Still another operation plans to denervate the adrenal glands and remove the celiac ganglion. The technical difficulty of performing this operation accurately is obvious. Another operation includes resection of the three splanchnic nerves bilaterally, removal of the first and second lumbar ganglia and removal of one-third to one-half of each adrenal gland. Recently, partial removal of the adrenal glands has been discarded as being wholly ineffective.

The best results from this last operation were obtained in young adults with hypertension who showed a marked fall in blood pressure after the administration of pentothal, amytal or nitrites. In another clinic the specific gravity of the urine and the urea clearance test are the criteria of operability, assuming that the latter test parallels the blood flow in the renal artery. However, the urea clearance test has been shown to improve in one patient with a postoperative fall in systolic blood pressure, to remain stationary in a second patient with a comparable fall in pressure, and in a third patient to improve without any fall postoperatively in blood pressure.

The results obtained by bilateral supradiaphragmatic removal of the splanchnic nerves in 48 patients has been reported by Freyberg and Peet.[9] Six patients showed a blood pressure reduction to 160/100 or less; in eight, the systolic drop never reached 160 but there was a reduction in systolic pressure of more than 60 Mm. In ten patients, the systolic reduction was between 30 and 60 Mm.; in 23 the pressure was unchanged and in one there was an increase in systolic pressure. Recently, Peet[10] reported that of 156 patients operated upon there was an operative mortality of 3.8 per cent; 34 patients had died later of their disease and of 100 patients studied, 48 per cent had a drop of at least 40 Mm. in their systolic pressure. Page and Heuer,[11] after anterior root section, stated that the renal efficiency, as measured

by urea clearance and the ability to concentrate urine, was unchanged either by the partial denervation of the kidneys which resulted from the operation or from the fall in blood pressure.

Adson, Craig and Brown[12] have reported 13 good results; six fair, six failures, and two deaths from anterior rhizotomy; two good, one fair, and four failures following splanchnic section with removal of the first lumbar ganglion, and five good and two fair results after splanchnic section, removal of the first and second lumbar ganglion and partial removal of each adrenal gland.

The surgical results, thus far obtained, are not conclusive. Neither the rationale nor the results of the operations are susceptible to an accurate physiologic explanation.

Our own work has been concerned with patients suffering from hypertension, and with the production of experimental hypertension. Our report at this time is purely in the nature of a preliminary communication to set forth the approach which we are making to this problem because we are convinced that by so pooling information the accurate solution of the problem at least from the surgical aspect may be arrived at more promptly.

Careful clinical studies were made upon the patients we have operated upon and in the majority of instances the patients have been under observation over a long period of time. The following criteria are used in choosing patients from the Renal-Vascular Clinic for splanchnicectomy:

(1) All patients have a severe grade of essential hypertension. Systolic pressures are 200 or over and the diastolic pressures are above 100 Mm. of Hg.

(2) As far as can be detected by a careful history, physical examination and laboratory data, there is no evidence of chronic glomerular renal disease.

(3) There is no evidence of peripheral arterial sclerosis. Angina pectoris or evidence of a high degree of spasm in the retinal vessels, or angiospastic renal disease, are not contraindications to operation.

(4) Throughout their months or years of observations, blood pressures showed normal fluctuations; that is, their pressures are not frozen at a definite level.

(5) All of the patients have been given a thorough trial with potassium sulphocyanate* over a period of several months up to two years. Cyanates

* Recently, one of us (M. H. B.) has reported upon the encouraging results of cyanate therapy, with a proper control of the blood cyanate level, in 45 patients with systolic blood pressures well over 200. These patients had been examined regularly and their blood pressures followed through periods of from one to four years on various forms of medical therapy. This selection of patients with individual variations, seasonal changes, environmental influence and other factors, enabled him to evaluate the results of therapy. Thirty-five patients in the group responded to a blood cyanate level of between 8 and 12 mg. per 100 cc. of blood by a reduction of the systolic and diastolic blood pressure and relief of their symptoms. Although the reason for the failure of ten patients to respond to cyanate therapy is not clear, it was evident that the most resistant cases presented evidence of well-advanced arteriosclerosis. It seems fair to point out, therefore, that patients with essential hypertension, regardless of their age, or the severity or stage of the disease, should be given a therapeutic trial with cyanates.

are discontinued for one of two reasons; either they show some response to cyanate therapy but the dose necessary to lower their blood pressure is large enough to cause symptoms of cyanate intoxication, or they are not sensitive to cyanates particularly in regard to their diastolic blood pressure.

Briefly, then, we choose only relatively young hypertensive patients without renal damage whose blood pressures under normal conditions show rather marked fluctuations; whose vascular tree is still elastic and who, over a long period of time for one of two reasons, have been found to be insensitive to cyanate therapy.

The patients are admitted to the hospital for a period of four or more weeks of critical study and blood pressure observations. These studies and observations consist of:

(1) Renal function tests of concentration and dilution power, urea clearance and fractional phenolsulphonphthalein excretion. Blood chemistry studies are made which include total protein, cholesterol, uric acid, blood and fluid volume, as well as glucose and insulin tolerance tests. Several check observations are made to insure the control findings. Blood pressures are taken morning and evening during bed rest for a period of four days, and continued until it is felt that a normal basal level has been reached. Blood pressure charts are kept along with the bedside notes and all pressures are graphed so that the general tendency of the course can be clearly seen.

(2) After normal reactions have been studied, the patient is next allowed to become ambulatory and pressures are taken; (a) while ambulatory; (b) after meals; (c) during periods of nervousness or excitement; and (d) while asleep. These are considered to be the pressures that might be reached under normal or working conditions during an average 24 hour day.

(3) Following this, the cold-pressor test is done according to the method described by Hines and Brown.[13]

(4) A nitroglycerine test is also performed (1/400 to 1/100 grain of nitroglycerine under the tongue), and the drop in the pressure is recorded each minute for a 20 minute period, or until the readings show that the pressure has returned to the average normal level.

(5) The changes in blood pressure during a period of deep sleep induced by amytal are then followed. Similar observations are made while under two types of anesthesia: Pentothal of sodium after the method described by Lunde and avertin anesthesia.

The above two methods are used as a measure of the patient's lowest probable pressure under artificially controlled conditions. Blood pressure readings taken after immersing the patient in a warm tub to promote peripheral vascular dilatation was also tried but the results, so far, have not been well enough studied to permit of further comment.

(6) In order to see just how high the blood pressure might be elevated under controlled conditions, the patient is cautiously given inhalations of carbon dioxide. A mask is placed on the patient's face, and oxygen is administered long enough for the patient to become accustomed to the mask and to breathe

naturally. After a basal level has been reached, the concentration of carbon dioxide is gradually increased to a level of 1, 3, 5, and rarely 7 per cent over a period of five minutes. Pressure readings are taken every 45 seconds until the distress of the patient is evidenced by hyperventilation, restlessness or dilatation of the pupils.

All symptoms noticed by the patient and all the observations upon the pulse, respiration and peripheral vascular bed are carefully recorded. These observations together with the blood fluctuations noted during this group of tests are then analyzed for the discussion of the feasibility of splanchnicectomy.

After operation, when the patient has recovered from the procedure and when the blood pressure has once again leveled off, the patient is rexamined by the same tests and all changes (if any) are noted.

It has been interesting to note that in patients whose daily fluctuations of pressure occur during periods of excitement, after meals, or following exercise, and whose pressure drops to relatively low levels at bed rest and during sleep, the average work load (systolic and diastolic blood pressure) of the cardiovascular-renal system corresponds almost directly to the high peaks of pressure and the low levels produced by the administration of carbon dioxide and during sleep respectively.

With one exception, the patients operated upon have been proven to be resistant to the administration of cyanates. That is to say, the blood pressure had not responded to this type of therapy, even when the blood cyanate level had been pushed to the maximum of safety with the patient at complete rest. The number of patients operated upon thus far is small, totaling six, because we have restricted our surgical indications to the comparatively small number of patients with essential hypertension who are cyanate resistant.

With one exception, each patient had a bilateral supradiaphragmatic section of the splanchnic nerves. In this single case, the splanchnic nerves were sectioned below the diaphragm, the lumbar sympathetic ganglia and chain were removed and a portion of each adrenal gland was removed elsewhere. But in this case, the patient had been adequately studied preoperatively by us and had proven resistant to cyanates.

Since this is in the nature of a preliminary report, we wish to report our results in a general manner, reserving until a later date the presentation of all of the statistical data upon each patient. We have observed an immediate fall in blood pressure following operation but in no case has it persisted longer than ten days. In each case the systolic and diastolic pressures have been returned to their preoperative levels. This has been so even in those cases which showed a drop in blood pressure following the administration of pentothal, amytal or avertin preoperatively. The blood chemistry determinations made at frequent intervals following observation have shown no decisive change but the insulin sensitivity test in each instance has given corroborative evidence of the fact that the splanchnic nerves have been sectioned thoroughly.

Two patients, including one operated upon by us and the one operated

upon elsewhere, have presented an interesting and, we believe, important response following operation. Whereas, in each instance the systolic and diastolic pressures have returned to their preoperative level with the return of all of the distressing symptoms of which the patients complained, and whereas, prior to operation they proved to be cyanate resistant after a long and adequate trial period, following operation, they now respond to the administration of cyanates with disappearance of all of their symptoms and a reduction in their systolic and diastolic pressures. In one instance, we are now in the process of allowing the blood to become free of cyanates, in an effort to see if the patient will again return to her previous high level and thus far, there is every indication that this is the case. We are, of course, unable to explain as yet the physiologic mechanism of this response in two patients but this constitutes one of the problems, the answer to which we are seeking in the experimental laboratory.

We have been able to produce hypertension experimentally in dogs, according to the method of Goldblatt, without the slightest difficulty. The most annoying part of the experiment is to be able to obtain blood pressure readings on animals with certainty and accuracy. As yet, we have not been able to place dependence upon any of the cuff methods, which have been used by others; nor have we been able to utilize the carotid loop method used to such advantage by Goldblatt. We have relied upon a manometric reading obtained by direct puncture of the femoral artery which, of course, provides the mean arterial pressure. All of the animals have been of the German shepherd breed and all have been trained to lie down on the table quietly while the blood pressure readings are made. Needless to say, readings have been made over a sufficiently long period to establish a normal range for each animal.

Our preliminary studies have indicated that experimental hypertension produced by renal ischemia can be reduced by the administration and the reduction of blood pressure as occurs in patients. The problem of the physiologic mechanism by which the cyanates reduce blood pressure and the relationship suggested between splanchnicectomy and the administration of cyanates, as well as the relationship of other organs to the problem of hypertension are now under investigation and we hope to present the final results of these clinical and experimental observations in later more detailed reports.

SUMMARY

(1) Thus far the various types of experimental hypertension cannot be said to be completely analogous to clinical hypertension.

(2) Experimental hypertension produced by renal ischemia involves an "effective substance" produced in the kidney and most closely simulates clinical hypertension. It is not affected by any type of operation upon the sympathetic nervous system.

(3) Agreement must be reached among investigators as to the patients who may be included under the term "essential hypertension."

(4) Observations upon patients with hypertension, who are chosen for operation, must be made over long periods pre- and postoperatively.

(5) The results obtained by any surgical procedure employed for the relief of hypertension must be explained upon anatomic and physiologic principles.

(6) A large number of patients with essential hypertension may be controlled by cyanate therapy so that they can continue their previous social and economic pursuits.

(7) Early results thus far obtained suggest a careful investigation of the relationship between the effect of cyanate therapy following splanchnicectomy in cyanate resistant patients.

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THE CLINICAL RESULTS OF CELIAC GANGLIONECTOMY IN THE TREATMENT OF ESSENTIAL HYPERTENSION

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IN THE treatment of essential hypertension we have performed 391 operations upon the adrenal sympathetic system in 230 patients. These have included 239 celiac ganglionectomies in 144 patients.

The effects of unilateral and of bilateral celiac ganglionectomy upon the blood pressure are shown in Tables I to V.

An interesting study has been made of the relation of the effects of bilateral celiac ganglionectomy to the age of the patient. An examination of Table VI would appear to show that advanced years, in themselves, are no contraindication to operation.

A comparison of the effects of celiac ganglionectomy on the blood pressure in cases of hypertension in the malignant and in the nonmalignant phases, indicates clearly that even in cases of advanced malignant hypertension the operation is not contraindicated (Table VII).

In order to see whether or not patients in whom the blood pressure either rose or showed no change in the diastolic pressure during a period of rest in the hospital were worse risks than those in whom the blood pressure fell during the preoperative period, a comparison has been made between the end-results in 15 consecutive cases in which there was either a rise or no change in the diastolic pressure during the preoperative period, and the end-results in 15 cases in which the blood pressure fell before operation. Table VIII shows that there is no significant difference between the results in these two groups of cases.

An interesting observation is that of this total group six died at varying periods after they left the hospital, and that in three of these six cases the blood pressure had decreased during the preoperative period.

The clinical results of these operations on the adrenal sympathetic system are judged: (1) By an examination of the eyegrounds, the heart, the kidney function, and the blood pressure of the patient; (2) by knowledge as to whether or not the patient is able to go back to his usual occupation; whether or not the headaches, the dizziness, the failing vision, the precordial pain, the heart-consciousness, and disability have diminished or disappeared. The follow-up studies have shown that a fall in blood pressure is not the only criterion upon which to base the effects of any procedure for the treatment of essential hypertension. The eyegrounds, the kidney function, the state of the heart, and not the least important, the effects upon the subjective symptoms must be considered. As to sclerosis, if it is present at the time of the operation, it will not entirely disappear. In Raynaud's disease, ganglionectomy will

TABLE I

EFFECTS OF UNILATERAL CELIAC GANGLIONECTOMY UPON THE BLOOD PRESSURE

	No. of Cases	Blood Pressure on Admission	Blood Pressure at End of Period	Difference
At end of hospitalization period	39	210/127	174/109	−36/18
1–3 mos. postoper.	24	208/126	195/121	−13/5
4–6 mos. postoper.	9	202/122	172/107	−30/15
7–12 mos. postoper.	8	194/111	162/95	−32/16
More than 1 yr.	4	203/120	171/96	−32/24

TABLE II

REDUCTION OF BLOOD PRESSURE TO NORMAL AS RESULT OF UNILATERAL CELIAC GANGLIONECTOMY

	On Disch. from Hosp.		1–3 Mos. Postoper.		4–6 Mos. Postoper.		7–12 Mos. Postoper.	
No. of cases	39		24		9		8	
Completely normal	41 %		12.5%		22.2%		25 %	
Blood pressure on adm.		186/116		171/109		157/107		185/105
Diastolic normal	56.4%		20.8%		42.9%		37.5%	
Blood pressure on adm.		196/117		190/114		182/106		195/113
Systolic normal	46.2%		12.5%		22.2%		37.5%	
Blood pressure on adm.		188/118		171/109		157/107		178/108

TABLE III

EFFECTS OF BILATERAL CELIAC GANGLIONECTOMY UPON THE BLOOD PRESSURE

	No. of Cases	Blood Pressure on Admission	Blood Pressure at End of Period	Difference
At end of hospitalization period	69	220/130	169/111	−51/19
1–3 mos. postoper.	55	219/135	181/115	−38/20
4–6 mos. postoper.	33	236/138	191/118	−45/20
7–12 mos. postoper.	19	221/134	193/119	−28/15

4–6 mos. postoper.	33	236/138	191/118	−45/20
7–12 mos. postoper.	19	221/134	193/119	−28/15

TABLE IV

THE EFFECT OF BILATERAL CELIAC GANGLIONECTOMY UPON THE DIASTOLIC PRESSURE

	No. of Cases	Diastolic Pressure Reduced 10 Pts. or More	20 Pts. or More	30 Pts. or More	40 Pts. or More	50 Pts. or More
On Discharge from Hosp.	69	73.9%	58 %	40.6%	26 %	14.5%
1–3 mos. postoper.	55	71 %	58 %	40 %	25.6%	9 %
4–6 mos. postoper.	33	64.7%	53 %	26.5%	14.7%	2.9%
7–12 mos. postoper.	19	68 %	47.9%	15.8%	5.3%	0

TABLE V

REDUCTION OF BLOOD PRESSURE TO NORMAL AS RESULT OF BILATERAL CELIAC GANGLIONECTOMY

	On Disch. from Hosp.	1–3 Mos. Postoper.	4–6 Mos. Postoper.	7–12 Mos. Postoper.
No. of cases	69	55	33	19
Completely normal	27.5%	18.2%	18.2%	15.8%
Blood pressure on adm.	197/119	192/126	198/122	193/128
Diastolic normal	40.6%	41.8%	30.3%	47.4%
Blood pressure on adm.	213/124	206/124	204/125	215/123
Systolic normal	31.9%	18.2%	21.2%	15.8%
Blood pressure on adm.	200/123	192/126	197/123	193/128

arrest the disease, but the sclerosis of the vessels will remain. Sclerosis is widely distributed in domestic animals and in wild animals in captivity. Sclerosis appears routinely in the sixth and seventh decades of life. It is responsible for the gradual rise in blood pressure with advancing years.

In essential hypertension there is a forced speed of sclerosis, due to the pathologic physiology. Clearly then, when, at the time of the operation there is present a certain degree of sclerosis, if the pathologic physiology is cured by operation, the patient will be physiologically cured, but, if the sclerosis is sufficiently advanced, the blood pressure does not fall to the normal level, just as the sclerosis of the aged maintains the blood pressure at a higher level than the normal for earlier ages.

As the result of celiac ganglionectomy, according to the results in our cases, the subjective symptoms—headaches, nervousness, fatigue, palpitation, dizziness, excitability, irritability, and heart-consciousness—have been relieved over a period of a year in 78 per cent of the patients. The eyesight has improved. Many patients have been able to return to their normal occupations even though the blood pressure has not been restored to the normal level. Even though the blood pressure has been reduced only from 280/150 to 180/120 or 200/130, the subjective improvement may be marked. Moreover, these patients tend to become calmer and more equable in temperament and thus even in cases in which the blood pressure remains well above the normal level the violent uprushes of the blood pressure with the disastrous results which may accompany emotional outbursts may be mitigated.

An analysis of the negative effects of celiac ganglionectomy also gives significant findings: Celiac ganglionectomy does not interfere with metabolism; it does not interfere with the digestive tract; it does not interfere with the genito-urinary tract; there are no orthostatic effects; there are no abnormal changes in the daily blood pressure; there are no changes in the skin; there has been no instance of adrenal insufficiency; there is no change in the rate of activity of the heart; there is no change in sex function.

The large majority of the patients operated upon for essential hypertension report a one- to five-year duration of symptoms. The duration of symptoms ranged, however, from one month to 25 years. Our studies have shown that the duration of symptoms has little effect upon the symptomatic results of celiac ganglionectomy, and our analysis has shown that the same is true for the other types of operation.

As for the operative risk among our last 123 celiac ganglionectomies there have been three deaths, a mortality rate of 2.4 per cent. The patient with essential hypertension, particularly in the malignant phase, is a poor risk for any impact of life—for any type of fever, for pneumonia, for pregnancy, for muscular exertion, for emotional excitement; in other words, the risk of operation in cases of malignant hypertension is little greater than the risk of life itself.

Since, according to vital statistics, 60 per cent of individuals with essential hypertension will sooner or later die of coronary disease; since in essential

TABLE VI

RELATION OF AGE TO THE EFFECTS OF BILATERAL CELIAC GANGLIONECTOMY

	Age 17–29 Yrs.			Age 30–39 Yrs.			Age 40–49 Yrs.			Age 50–61 Yrs.		
	Adm.	Disch.	Dif.	Adm.	Disch.	Dif.	Adm.	Disch.	Dif.	Adm.	Disch.	Dif.
On Discharge from Hosp..	201/146	176/123	−25/23	225/165	206/122	−19/43	201/146	168/107	−33/39	219/125	167/ 99	−52/26
1–3 mos. postoper.....	224/147	182/128	−42/19	225/149	183/120	−42/29	213/143	190/120	−23/23	212/144	184/120	−28/24
4– 6 mos. postoper.....	220/143	162/108	−58/35	214/131	179/114	−35/17	216/132	180/111	−36/21	221/134	184/116	−37/18
7–12 mos. postoper.....	219/125	167/100	−52/25	212/125	182/113	−30/12	230/126	138/117	−92/9	212/148	189/120	−23/28

TABLE VII

EFFECTS OF CELIAC GANGLIONECTOMY UPON BLOOD PRESSURE IN MALIGNANT AND NONMALIGNANT HYPERTENSION

	No. of Cases				1–3 Mos.			4–6 Mos.			7–12 Mos.		
		Adm.	Disch.	Dif.	Adm.	Postoper.	Dif.	Adm.	Postoper.	Dif.	Adm.	Postoper.	Dif.
Malignant hypertension.....	16	234/148	185/119	−49/29	235/149	198/129	−37/20	229/147	204/123	−25/24	231/146	207/131	−24/15
Nonmalignant hypertension.....	16	221/113	170/107	−51/26	219/131	182/113	−37/18	216/132	185/118	−31/14	221/139	192/123	−29/16

TABLE VIII

COMPARISON BETWEEN THE RESULTS OF CELIAC GANGLIONECTOMY IN 15 CASES IN WHICH THE BLOOD PRESSURE ROSE WITH THOSE IN 15 CASES IN WHICH THE BLOOD PRESSURE FELL DURING A PERIOD OF REST IN THE HOSPITAL

		After Period			1–3 Mos.			4–6 Mos.			7–12 Mos.		
	Adm.	of Rest	Disch.	Dif.	Adm.	Postoper.	Dif.	Adm.	Postoper.	Dif.	Adm.	Postoper.	Dif.
Rise in blood pressure before operation...	224/129	226/145	172/110	−52/19	219/126	192/112	−27/14	228/128	194/114	−34/14	202/127	175/107	−27/20
Fall in blood pressure before operation...	217/137	181/111	172/116	−45/21	217/137	183/119	−34/18	214/142	188/118	−26/24	216/146	184/124	−32/22

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hypertension the heart has tremendous work imposed upon it because of the effort to circulate the blood against the high pressure, one might expect that heart failure would be one of the outstanding risks of the operation. In our entire series of cases not a death has resulted from heart failure. As soon as either the adrenal gland or the celiac ganglion is interfered with there is a fall in the blood pressure.

In 56.5 per cent of the cases in which bilateral celiac ganglionectomy was performed, the blood urea was decreased in 34.8 per cent to the normal level. Considering the general mortality from kidney failure and heart failure in cases of malignant hypertension, the low operative mortality is better than what one would expect. If in the presence of hypertension one is forced to operate upon the gallbladder or upon the stomach, the burden falls on the brain, the heart, and the kidneys, whereas, when celiac ganglionectomy is performed this burden is lessened and, therefore, it is logical to find a lower mortality from celiac ganglionectomy than from any other operation in the presence of malignant hypertension.

One point was made very clear by our experience and that was that when the kidney function is impaired there is very great danger in allowing the blood pressure to fall to too low a level. The blood pressure should be maintained at, or above, a certain level, say 100 systolic as a minimum.

The question has been raised by clinicians of large experience as to whether the reduction in the blood pressure in essential hypertension may not have a deleterious effect upon certain organs. In this regard our experience has shown that there is no risk to the function of an organ in restoring the blood pressure to its normal level. In some cases the patients for a time experience a state of diminished energy which is somewhat comparable to the state of transient hypothyroidism.

The determination as to the operability of a case of hypertension is in part dependent upon the laboratory findings, and, in a very large part, upon the experience of the operator. As to the end-results, in the long run the value of any surgical procedure and medical measure is told by the patient himself. If the patient is able to return to his former occupation, if he is relieved of his subjective symptoms, then that determines, and that only, the value of operation. The value of the surgical treatment of exophthalmic goiter, peptic ulcer, gallbladder disease—the value of all surgical attempts is determined by the patient. No problem is settled until the patient is satisfied.

DISCUSSION OF PAPERS OF DOCTORS DAVIS AND CRILE

Dr. Francis R. Hagner (Washington, D. C.).—I would like to mention a case which is not my own, but one I saw with Dr. David Mackenzie of Montreal, which I do not think has as yet been reported. The patient complained of pain over the right eye. The blood pressure varied from 129 to 190. After careful study, a diagnosis of adrenal medullary tumor was made. He was operated upon, and the left adrenal was examined first; nothing was found. Examination of the right adrenal disclosed a cyst, pressure upon which caused the patient's blood pressure to rise to 240. The cyst was re-

moved, and found to contain black fluid. The pain disappeared and the patient made a good recovery; the blood pressure had never been over 125 during the first four weeks postoperative.

Some time ago I saw an article in the paper about an old gentleman in North Carolina who had had a cardiac attack. This problem, as we all know, is sometimes difficult. It is hard to tell how to treat them. This old gentleman was 90, and was married to a lady of 28, and had a child two and one-half years old. Six months before he had this cardiac attack he had another child. The doctor said he was doing pretty well and they thought he would recover. It occurred to me that this case presented a problem in treatment—whether to keep this old gentleman out of bed or in bed.

Dr. F. G. DuBose (Maplesville, Ala.).—The last work done by me was on the vegetative nervous system, observations on paravertebral alcohol block for asthma, angina and other conditions.

The papers read on this subject impress me with mass production in surgical procedures looking to the remedy of hypertension. Interesting indeed are the reported results from the use of the scalpel. One is reminded of the shotgun prescription of the early days, when through polypharmacy the chance of a cure might follow. From out of this evolved specific therapy; so also, it is hoped from out of the multiple operations, and the many tissues involved, we may progress into a determinative technic. The basic element of cause and effect must be kept in mind in all treatment. The outstanding work of Crile had proven the rôle the emotions play in hypertension. The mental stress or adverse emotional stimuli are well recognized factors in the etiology of high blood pressure. How much the personality of the surgeon and the influence of his suggestive powers play in the result of any surgical operation he may do should not be put out of the picture. As illustrative of this I would like to report a case of our own Dr. J. M. Mason, Alabama's outstanding surgeon, and in so doing pay a tribute to his outspoken honesty and sympathetic candor in his relationship to those under his care.

The patient was a man with hypertension, coronary occlusion and dilatation, and associated sequelae, which made his condition most serious. He told him of rest, diet, sensible acceptance of coming under the rules laid down, avoiding worry and cultivation of cheerfulness, insisting that if these were not followed he would certainly die. He performed no surgery, yet the convalescence of the man was unexpectedly good; recovering to well nigh normal limits when he was visited by a tragic disaster and added to that a great sorrow. During this unfortunate period he had a profuse nose bleed all night; bled white, yet the next day his systolic pressure was 280 Mm. Doctor Mason again enjoined absolute rest and an optimistic philosophic responsiveness. Under this plan of controlling his emotions, putting him *en rapport* with all that touched him, the blood pressure gradually came down to 130 systolic and his recovery was steady and uninterrupted. He was given a life expectancy of 18 months in the beginning, but by such temperamental, emotional or psychic adjustment has extended it to six years. Had any operation been performed, coincidental with the exercise of the surgeon's influence through the faith he commanded, and the wise philosophy exercised, it would have been written down as a remarkable surgical achievement. I wonder. Don't you?

Dr. Mims Gage (New Orleans, La.).—I would like to ask Doctor Crile a question: We are now operating upon the splanchnic nerves and the celiac ganglia for essential hypertension to obtain reduction of the blood pressure

and relief of symptoms; and as we have no method to determine preoperatively the beneficial results to be obtained by operating upon the splanchnic nerves and the celiac ganglia, would it not be possible, and advantageous, to chemically section the splanchnics with novocain by the method of Kappis, in order to foretell the results which might be expected from the operation?

This method of preoperative blocking of the sympathetics is extensively employed as a routine procedure before any operation is undertaken upon the cervical or lumbar sympathetics in peripheral spastic vascular disease of the extremities, in order that the results to be obtained by their abolition can be predetermined.

Dr. George Crile (closing).—The question that was asked me regarding the fall in blood pressure during celiac ganglionectomy is very important. It is not only a question of the blood pressure being reduced far enough, but it may be reduced too much. In one case the blood pressure was reduced so much that it could not be measured by the manometer. We used every means in our power to raise it and finally succeeded after six or eight hours, but during that time the kidneys, which had already been damaged by the hypertension, failed, and we lost the patient. This experience taught us to avoid the use of novocain in these operations. Manipulation of the ganglion and the sympathetic complex will cause a temporary rise of the blood pressure, but as soon as the celiac ganglion is removed the blood pressure falls often to within normal limits.

THE ADVANTAGES OF THE ABDOMINAL APPROACH TO INGUINAL HERNIA

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THE approach to the sac of an inguinal hernia through the abdominal cavity has been described by a number of authors during the past 20-odd years, but the real advantages of this method have apparently not been widely recognized or appreciated. On account of this lack of interest it would seem appropriate for me to review these advantages since two of the advocates of this method are Richmond surgeons.

The first reference in the literature to the abdominal approach which I have found is by Dr. Charles R. Robins[1] of Richmond, Va., who, in 1909, advocated a right rectus incision for the release of strangulated inguinal hernia. A few years before, Dr. Alexis V. Moschowitz,[2] of New York, wrote of operating upon femoral hernia by approaching the neck of the sac above Poupart's ligament, but he did not open the peritoneal cavity other than through the neck of the sac. In 1919, Dr. G. Paul LaRoque,[3] of Richmond, presented modifications of these operations and later, in 1924,[4] 1931,[5] and 1932,[6] discussed its employment in various types of hernia.

My interest in this method was first aroused by Doctor LaRoque, and I was easily persuaded to employ it in selected cases after I discovered the ease with which the sac could be removed from above. My first experience was with a boy who had mild, acute appendicitis. His mother requested that his right inguinal hernia be repaired at the same time. I did not agree to this, but when I had removed the appendix the internal opening of the sac was so inviting that I pulled it up, withdrew the whole sac into the peritoneal cavity, cut it off, closed the defect, and did not disturb the inguinal canal. There has been no recurrence of the hernia.

In the LaRoque operation the usual inguinal incision is made and the external oblique opened into the external ring. The internal oblique and transversalis muscles are then opened about one inch above the internal ring as one would in a McBurney incision, and the peritoneal cavity opened. The internal opening of the sac is readily seen by lifting upward on the lower leaf of peritoneum. Exploration for other openings is quickly made. The edge of the internal ring is caught with forceps (Fig. 1) and the peritoneum dissected bluntly around its circumference. When the peritoneum of the sac is cleared the cord can usually be brushed away from it and the entire sac delivered. The excess of peritoneum including the entire sac and its internal opening is cut away. The inguinal canal can now be repaired according to the wishes of the operator. Finally, the appendix can be removed in most cases when the hernia is on the right side, and the wound closed.

There is no particular reason for using this method in the ordinary simple indirect inguinal hernia nor is there any advantage in direct hernia. There are, however, six conditions, each of which will be discussed briefly, where it is of real help to the operator.

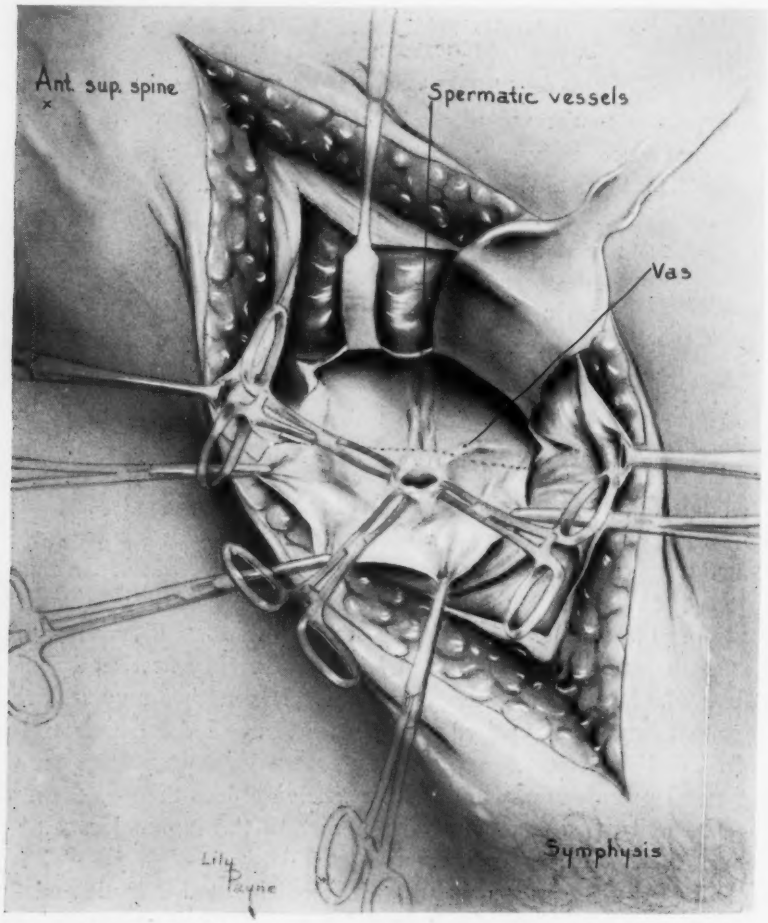

FIG. 1.—The internal ring seen from above through the muscle splitting incision. (Modified from LaRoque.)

(1) The first is when the *appendix should be removed,* or when it is suspected of having been inflamed. I have had several cases where the patient attributed pain to the hernia, but a definitely inflamed appendix was removed and was doubtless the cause of the trouble.

(2) I advise this approach on all *strangulated herniae.* The advantage is that the bowel is entirely under control at all times, the internal ring can be more readily released, and the canal portion of the sac can be opened at the same time if the bowel is caught by a lower ring or is adherent in the sac. After the bowel has been released there is sometimes doubt of its viability, with the peritoneal cavity opened the loop can be replaced in the cavity

FIG. 2.—Omentum removed from an incarcerated hernia by the LaRoque method. The large dark portion on the left was in the abdomen. The smaller light portion to the right was in the hernia sac.

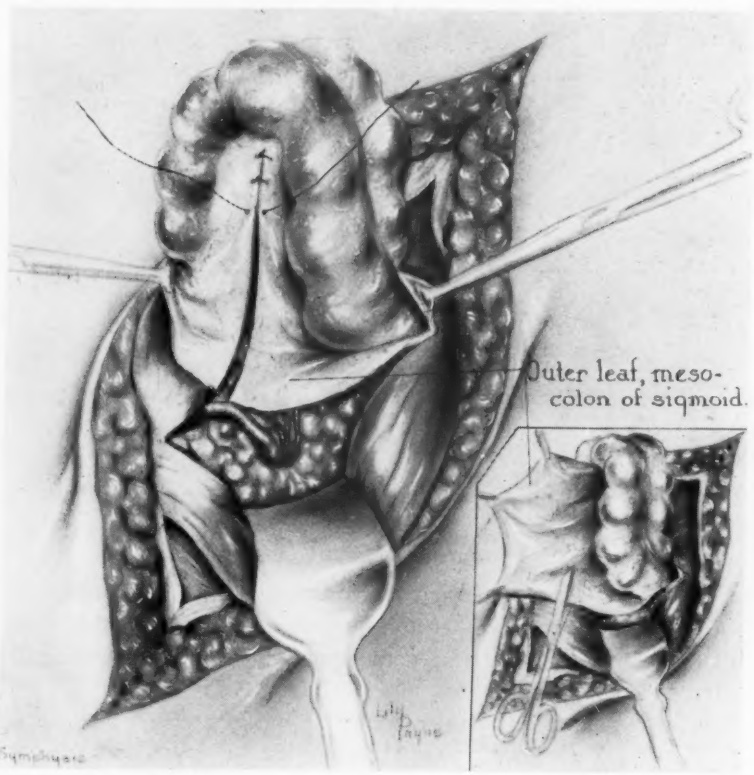

FIG. 3.—Reconstruction of the mesosigmoid after reduction of sliding hernia and removal of excess peritoneum. Inset shows removal of excess peritoneum. (Modified from LaRoque.)

and inspected as desired. Finally, if resection is necessary, a good exposure of the mesentery is obtained, while it is often quite difficult through the sac from below.

(3) *In large indirect herniae* particularly when there is incarceration of abdominal organs. In one case where there was obviously incarcerated omentum in a very fat man, I found a mass of strangulated omentum in the

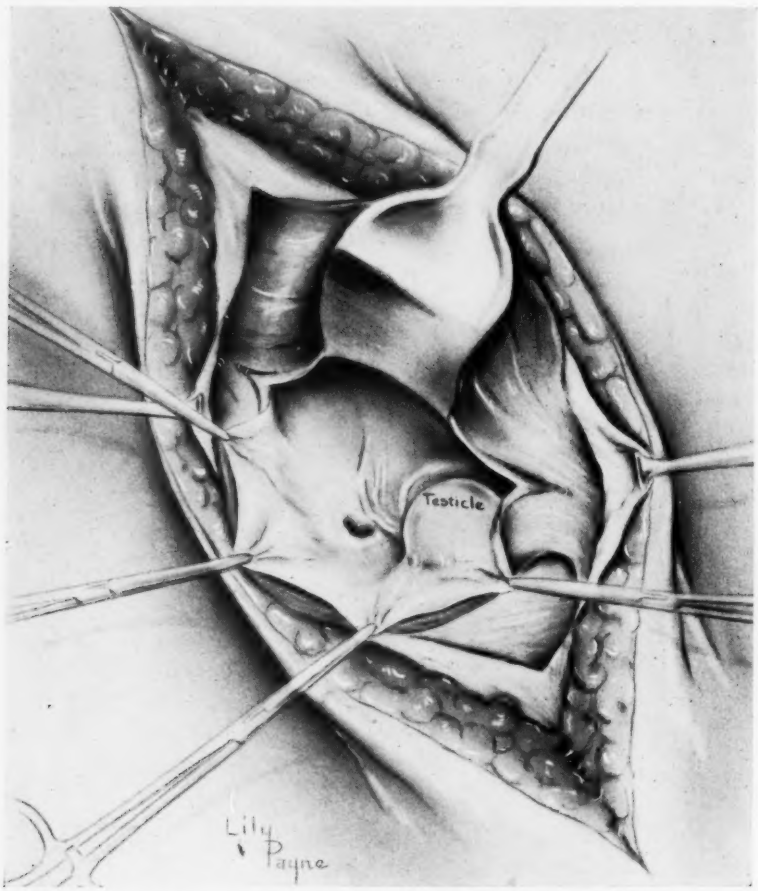

FIG. 4.—Internal ring and intra-abdominal testicle seen from above through the muscle splitting incision.

peritoneal cavity (Fig. 2) which was continuous with the healthy omentum of the sac. If this hernia had been approached from below, this mass could easily have escaped detection and would certainly have been much more difficult to remove if it had been found.

(4) I have not had the opportunity to operate upon a *sliding hernia* through this approach (Fig. 3). However, it is easy to visualize the advantage of delivering the sigmoid or cecum from above. The incomplete sac can be trimmed to the proper size and its edges used to reconstruct the mesocolon as it should normally have been. The cavity would then be

closed and the inguinal canal repaired. In women I have found, not infrequently, that the tube and rarely the whole broad ligament has slid into the sac in much the same manner as does the sigmoid and cecum. This situation is much more readily corrected through this incision and in any case exploration of the pelvis is possible.

(5) *Congenital type of hernia.* I have often found it difficult to separate the extremely thin sac of a young child from the vas deferens, and have occasionally been embarrassed by the peritoneum tearing along the vas so that

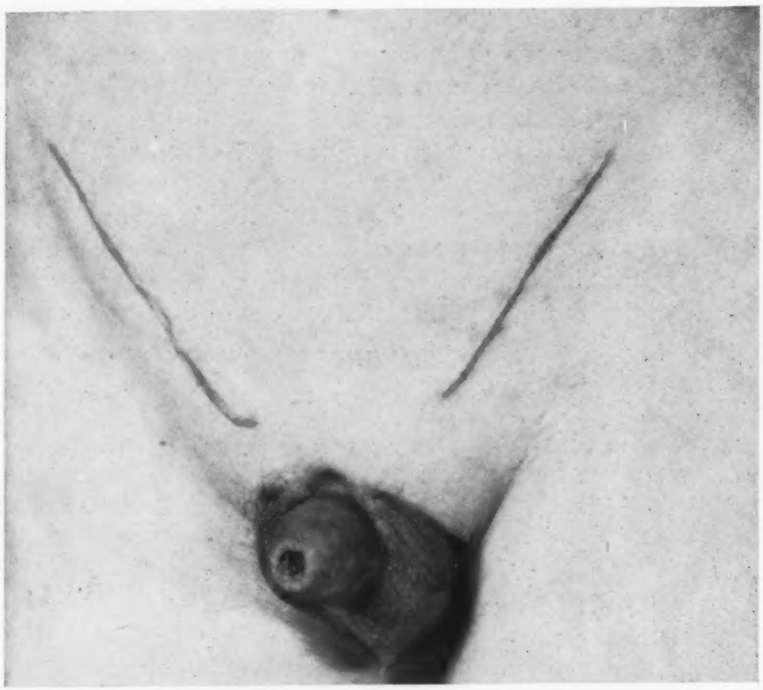

FIG. 5.—After operations by the LaRoque method for bilateral intra-abdominal testicles. Both testicles are in the scrotum.

it was quite difficult to close the neck of the sac. When approached from above, the neck of the sac can be dissected above the point of contact with the vas so that any tearing would be downward and of no consequence since some of this sac must be left in place. With the connection of the sac to the peritoneal cavity broken, it is usually unnecessary to make any repair of the inguinal canal.

(6) *Undescended testicle.* When once one has approached an undescended testicle from above he will never again try it from below. The same ease of dissection of the sac is found here as was described above for congenital hernia. The additional great advantage is that the peritoneum can be pushed upward on the posterior abdominal wall and a wider exposure made of the vas and the spermatic blood vessels. The adhesions which are so often present can be divided, unimportant veins can be removed, and with

this wider dissection greater length of the cord can be obtained. When the testicle is completely intraperitoneal (Fig. 4), the hernia sac can be quickly disposed of and then all of its connections are clearly in view and a good cord can be developed. I have recently operated upon both sides, with a year's interval, in a boy age 12 (Fig. 5). I would not consider any other approach for such a case.

I know of few objections to this method and all of them are of slight consequence. It is of course a little more time consuming but the few additional minutes rarely make any difference. Theoretically, opening the peritoneal cavity more widely and removal of the appendix may result in intraperitoneal adhesions or wound infection. Either is too remote a danger to deserve serious consideration under modern conditions.

CONCLUSIONS

The abdominal approach to the sac of an inguinal hernia has many advantages which are not generally appreciated. It is advocated in cases where the appendix should be removed, in strangulated hernia, in large, complicated, indirect hernia, in sliding hernia, in the congenital type of hernia, and in hernia associated with undescended testicle.

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DIVERTICULUM OF THE FEMALE URETHRA

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DIVERTICULA occur most frequently in the gastro-intestinal and genito-urinary tracts. The esophagus, duodenum, and large intestine are the more common locations in the alimentary tract, and the urinary bladder in the urinary system. Diverticula of the bladder occur much more often in men than in women. In a total of 238 cases which we have observed, only six were in women.

Since Sir Charles Mansfield Clark's[1] publication, in 1814, and again 17 years later, of papers dealing with diverticula of the female urethra, increasing numbers of observations regarding this interesting subject have become available. Amand Routh,[2] in reviewing the literature up until 1891, found reports of 20 cases, and since that time probably twice that number have been recorded, the majority having been published during the last two decades.

Generally speaking, two theories regarding the etiology of diverticula in the female urethra have been advanced: (1) The congenital; and (2) the acquired; the latter are divided into traumatic and infectious.

Evidence in support of the congenital theory is advanced by Englisch,[3] of Vienna, who reported that he had observed diverticula of the urethra in infants at birth. Folsum[4] has reported two cases in which an aberrant ureter opened into a diverticulum. Other writers who support the congenital theory delve deeper into the embryology and the numerous possible deviations from the normal.

The "acquired" theory has, however, been the most widely accepted and supported. Although the condition has been reported to occur in patients at any age from childhood to 60 years, trauma and infection, either separately or together, have most often been associated with the formation of the diverticula. Closure of the ducts of the urethral glands resulting in retention cysts which later may become infected and rupture into the urethra is cited as one cause by Amand Routh.[2] Trauma to the urethral floor during labor and instrumentation is accepted as the cause by many others.

Infection of the urethral glands, although frequently eradicated with difficulty, usually drains into the urethra. Obstruction to the drainage with plugging of the glands may result in the formation of an abscess which later may rupture into the urethra and leave a sac-like cavity. As suggested by Furniss,[5] some back pressure occurs at each voiding and this may further distend the sac. The back pressure takes place because the narrowest point in the female urethra is at the external meatus. Secondarily infected blood cysts in the vesicovaginal septum may rupture into the urethra to form a diverticulum.

From our own observations in a rather large series of diverticula of the urinary bladder, we believe that most diverticula are secondary to some obstruction to the urinary outflow, not only in the men but in our six cases which occurred in women. There were obstructive symptoms in nearly all urethral caruncles, fibrosed bladder neck, congenital stricture of the urethra, *etc.*, in the women; and strictures, enlarged prostates, *etc.*, in the men. While there may be some congenital defect acting as a predisposing cause, the obstruction to the bladder outlet causes the development of most diverticula.

From time to time, articles have appeared in which an attempt has been made to determine whether the diverticulum in question is "true" or "false," the determining factor being the presence or absence of a definite muscularis when examined histologically. An epithelial lining of the cavity has also been considered as essential if a diverticulum is to be considered as the "true" type. Infection frequently erodes and removes the epithelium from the lining of the cavity completely.

The term urethrocele, which is so often applied to these cases, would imply a very wide-mouthed diverticulum or a dilatation of a considerable portion of the urethral floor. For the sake of simplicity, the definition of a diverticulum of the urethra suggested by Routh[2] might be used: "The diverticulum is essentially a urinary pouch or cyst communicating with a urethra of normal caliber, usually in its middle third, by an orifice relatively narrow."

Not all diverticula of the female urethra give rise to symptoms of sufficient severity to cause the patient to consult a physician. When medical advice is sought, the symptoms usually consist of frequency and dysuria, a sensation of painful discomfort when sitting, dyspareunia, and occasionally there may be some involuntary escape of urine. Examination may reveal a visible and palpable swelling of the anterior wall of the vagina. This swelling is cystic in nature and, when acutely inflamed, becomes exquisitely tender. Pressure over the mass may force the fluid contents out through the urethra. Urethroscopic examination may reveal the site of the ostium in the floor of the urethra—most frequently in the middle third. Small catheters or probes may be inserted into the cavity. Roentgenologic demonstration of the lesion is easily carried out by filling the diverticulum with a radiopaque substance.

Various methods of treatment have been tried, including the injection of sclerosing solutions, incision and drainage, and excision of the diverticulum. For consistently good results, excision of the diverticulum accompanied by diversion of the urinary stream by means of an indwelling catheter for a period of five to seven days has been most widely recommended. While some authors have allowed the vaginal incision to granulate in the presence of infection, it is felt that almost all these patients convalesce more quickly when the wound is tightly closed or is drained for only a short period of time.

The following case of a diverticulum of the urethra in a female has recently come to our attention.

Case Report.—The patient, a white female, age 52, had had two prolonged labors 26 and 33 years previously. No discomfort had been experienced until six years ago,

since which time she had had recurrent episodes of dysuria, and complained of a sensation of soreness in the urethra when sitting.

Examination revealed a somewhat cystic, tender mass between the anterior wall of the vagina and the urethra. Pressure on the mass caused great discomfort. Suspecting the possibility of a diverticulum being present, a urethrogram was made, which showed a diverticulum very definitely situated at about the middle of the urethra. Upon urethroscopic examination a small opening could be seen. A catheter was passed into the opening and vaginal examination showed it to lie in the mass. Probing the pocket with the catheter reproduced the patient's pain.

Excision was advised and carried out through an incision in the vagina over the mass. The entire diverticulum was removed, the edges of the urethral defect being turned in and the incision closed tightly. A gauze roll was inserted in the vagina, in order to exert pressure on the operative site, and this was left in place for 48 hours. A soft rubber urethral indwelling catheter was left in place for six days. The wound healed perfectly, and the patient's symptoms have been entirely relieved.

CONCLUSIONS

We believe that a more careful examination of the urethra should be made in women who have had a prolonged history of irritation during or following urination, and in whom examination has not revealed any special pathology in the bladder. It is quite possible that some of these symptoms may be due to a diverticulum of the urethra which has been overlooked.

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DISCUSSION.—DR. GUY L. HUNNER (Baltimore, Md.).— Doctor Lower renders a real service in calling attention to this condition of urethral diverticulum, whether it occurs with abscess or cyst formation. While a comparatively innocuous condition in some individuals, it is capable of causing great suffering and much ill health, which it does in many cases because of a lack of early diagnosis. Doctor Lower's paper has emphasized the ease of diagnosis if one has the condition in mind. Many methods of treatment have been proposed, from simple incision and drainage to various modes of thermosurgery. I agree, however, with Doctor Lower that the most effectual method consists in excision of the sac and closure of the three layers of tissue for per primam healing.

To add interest to Doctor Lower's paper I wish to speak of a rare complication in suburethral diverticulum—that of calculus formation. During my first 35 years in gynecologic work, I think I saw at least 12 or 15 cases of diverticulum, without seeing a case of stone in the sac; then in April, 1933, two cases of this rare complication applied to the dispensary service within 48 hours. We have had a third case since.

Case 1.—A white woman, age 77, was admitted April 20, 1933. The younger of her two children had been born 32 years previously. For 37 years she had complained of frequency of voiding and occasional incontinence. For the past three years the patient had noticed a small nodule in the introitus of the vagina. This gradually seemed to grow larger and the incontinence had increased until she was forced to wear a pad on leaving the house.

Operation.—In addition to excision of the sac with its stones and the usual closure, we shortened the sphincter urethrae muscle by plicating it with a mattress suture of 20-day No. 0 catgut. She had some difficulty in voiding for the first few days after removal of the catheter, probably due to the shortening of the sphincter, but on dismissal, on the twelfth day, she seemed normal in every way.

The suburethral sac contained 17 stones, one measuring 18 Mm., another 13 Mm., and the others less than 1 cm. in diameter.

Case 2.—A colored woman, age 52, was admitted April 22, 1933. She had never been pregnant. Her chief complaint was bladder trouble. She said that I had treated her for bladder symptoms on three occasions 15 years previously. For five months before her admission there had been rather severe bladder symptoms with much straining, and a small lump had appeared in the vulva when she strained. On examination, with the patient straining, a protrusion, resembling a cystocele, separated the hymen edges slightly; and on palpation there was apparently a suburethral diverticulum containing a calculus mass measuring about 2 cm. vertically and 1.5 cm. laterally.

I assisted Dr. Gerald Hurd, our resident gynecologist, in removing the suburethral diverticulum and the large stone. It was a difficult dissection and after removal of the sac we found two rather large openings on the floor of the urethra. Each of these was closed with a square figure-of-8 No. 0 plain catgut. The suburethral layer was closed with interrupted 40-day No. 00 catgut. An oval piece of vaginal mucosa had been excised with the sac, and the vaginal edges fell together in such good apposition that we decided not to take the third line of sutures but to trust the pressure of the gauze roll in the introitus to result in per primam healing. At the time of her dismissal, 23 days after operation, the patient had had perfect control and had no nocturia.

Case 3.—A colored woman, age 66, applied at the gynecologic dispensary October 15, 1935, complaining chiefly of frequent and painful urination. The patient had had two children, the first one 32 years previously. A year ago she noticed that whenever she caught cold she developed burning and frequency and had nocturia six to eight times. An attack of this character was ushered in with a head cold about two weeks before admission and for two days there was dark red urine with clots.

Dr. Erle Henriksen, our resident gynecologist, had charge of this case, and he described the suburethral mass as being the size of a pullet's egg. There was difficulty in passing the glass catheter, this being facilitated by dragging the sac with its stone away from the symphysis. He removed the sac with its stone and closed in three layers. The patient was dismissed on the sixth day and returned on the twelfth day free from urinary symptoms.

THE MODERN TREATMENT OF VARICOSE VEINS AS INDICATED BY THE COMPARATIVE TOURNIQUET TEST

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ONE year ago we described a new test[1] for evaluating circulation in the venous system of the lower extremity affected by varicosities, and indicated the significance of this test in directing the proper treatment of varicose veins.

The modern trend in the treatment of varicose veins is a combination of ligation of the internal saphenous vein and injection of varicosities with some sclerosing solution. A very prevalent teaching concerning ligation is that the internal saphenous vein should be sectioned and ligated high above any of its tributaries in order to keep at a minimum the incidence of recurrence. The test which we present shows why this alone is insufficient treatment in many cases of varicose veins; in addition, the test will indicate where the retrograde flow from the deep to the superficial system occurs, *i.e.*, whether the reflux takes place through the internal saphenous vein alone or through communicating veins from the deep to the superficial system as well.

TESTS FOR EVALUATING THE CIRCULATION IN THE VENOUS SYSTEM OF THE LOWER EXTREMITY AFFECTED BY VARICOSITIES

With the several tests which have been advocated for investigating the circulation in varicose veins, the following information should be determined:

(1) Competency of the valves in the long saphenous vein.

(2) Competency of the valves of the communicating veins.

(3) Patency of the veins communicating between the superficial and deep system.

(4) Patency of the deep veins.

(5) Relative impairment of the arterial supply to the extremity.

To obviate unnecessary repetition in describing these tests, which have been previously reported,[1] we will consider only two of them: The Trendelenburg-Brodie test, and the comparative tourniquet test of Mahorner and Ochsner.[1] The first of these, described initially by Brodie[2] and later, but apparently independently, by Trendelenburg,[3] was employed by Trendelenburg as follows: The patient reclines on a table and the leg is elevated so that the veins are above the level of the heart. The veins promptly empty. The patient assumes the sitting position and then the standing position, and it is noted whether the veins fill quickly or slowly. The same performance is now repeated, but after the veins are emptied the hand of the observer is placed over the upper end of the long saphenous vein firmly enough to prevent the passage of blood through it. The patient, with this pressure maintained, then sits up and again stands. The pressure is maintained only momentarily, and when

released the observer notes the blood as it rushes downward through the internal saphenous system to suddenly distend the varicosities. The immediate distension of the veins when the pressure is released indicates incompetency of the valves in the saphenous vein, and in such instances the Trendelenburg test is considered to be positive.

A further adaptation of this test is the determination of the so-called doubly positive reaction. Instead of releasing the pressure over the internal saphenous vein, the observer maintains it for 35 seconds, to determine if the varicosities distend in spite of the continued pressure over the saphenous vein. If the varicosities become distended to their full prominence within 35 seconds, it indicates that the blood, unable to return through the saphenous vein with its incompetent valves, has found another shortcut by way of the communicating veins, whose valves, therefore, must have become incompetent since the flow through these communications is normally from the superficial to the deep system. If the varicosities take 35 seconds or longer to distend fully, with the observer exerting pressure over the internal saphenous vein, the interpretation is that the valves of the communicating veins are competent. The blood, not being able to return through the varicosed saphenous vein with incompetent valves because of pressure exerted by the observer, and not being able to return through the communicating veins because their valves are competent, must, therefore, reach the varicosed superficial veins by the normal route passing through the capillaries; and it requires approximately 30 seconds for sufficient blood to do this in order for it to distend large varicosities.

The comparative tourniquet test described by Mahorner and Ochsner[1] combines the advantages of the several other tests and when correctly interpreted gives one extensive information concerning the condition of the circulation in the varicose veins of the lower extremity.

The patient is observed standing, draped so that the two legs and thighs can be seen. The observer sits with the light behind him and with the level of vision low so that the veins of the calves and thigh can be easily seen. The patient walks to and fro in front of the observer (Fig. 1). Even with no tourniquet on the varicosities become less prominent when the patient is walking, because the peripheral pumping action of the muscles on the deep veins sucks the blood from the superficial system and helps return it to the heart. The patient then stops and a tourniquet is applied around the upper third of the thigh sufficiently tight to compress the superficial veins and obstruct the flow of blood through that segment. The patient walks again over the same course and at the same speed. The prominence of the varicosities is noted and compared with their prominence when walking without the tourniquet and again when walking with the tourniquet around the middle third of the thigh and again when walking with the tourniquet around the lower third of the thigh. The prominence of the varicosities is thus observed under five different conditions: Standing; walking without the tourniquet; walking with the tourniquet around the upper third of the thigh; around the

FIG. 1.—Drawings illustrating performance of the comparative tourniquet test for determining the competency of the valves of the veins communicating between the deep and the superficial systems and patency of the deep veins of the leg (Mahorner and Ochsner: Archives of Surgery, 33, 479–492, 1936). The patient walks at a normal gait, and the prominence of the veins of the calf is noted (a). Thereafter the tourniquet is applied to the upper third of the thigh (b), sufficiently tight to compress the superficial veins. Observations are made for comparative changes in the appearance of the veins of the calf. The tourniquet is likewise applied to the middle and the lower third of the thigh (c) and (d). The patient walks over the same course, and the prominence of the veins is noted. If the deep and communicating veins of the thigh are patent there is diminished prominence of the veins of the calf when the patient walks with the tourniquet applied. If the valves of the communicating veins are incompetent when the patient walks with the tourniquet around the upper third of the thigh, there is some diminution in the prominence of the varicosities, but they do not entirely disappear because the blood spills through the incompetent communicating veins from the femoral to the long saphenous vein. When the tourniquet is below the lowest communicating vein of the thigh in which the valves are incompetent (d), the varicosities of the calf collapse or disappear. When valves of the communicating veins are incompetent high ligation alone is not sufficient, and low ligation also must be performed to interrupt retrograde flow through communicating veins. If the varicosities of the thigh and leg completely collapse, *i.e.*, disappear, when the tourniquet is around the upper third of the thigh and there is no further improvement when the tourniquet is around lower levels, then the valves of the communicating veins are competent and high ligation and section of the saphenous vein are sufficient to interrupt the retrograde flow from the deep system. In (b) slight improvement (diminution in prominence) is shown over that indicated in (a), in a case in which the blood spills through the communicating veins below the level of the tourniquet. In (c) more improvement in the veins of the calf is shown, and in (d) the greatest improvement appears. If the improvement shown in (b) were complete, the test would indicate competency of the valves of the communicating veins of the thigh, but incompetency of the valves of the internal saphenous vein.

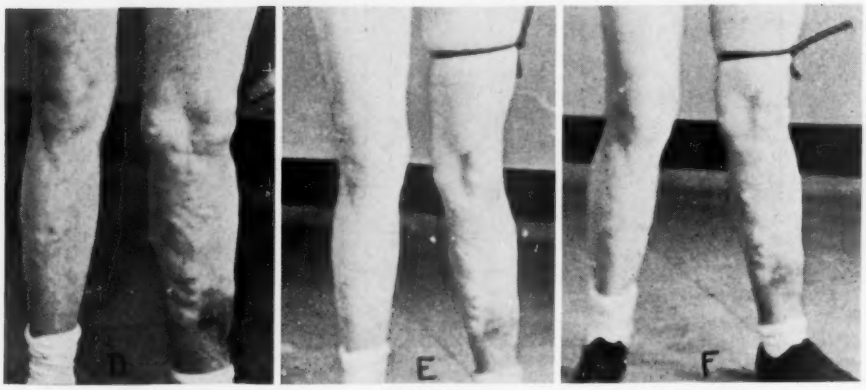
middle; and around the lower third of the thigh. When the patient walks with the tourniquet applied, the varicosities are less prominent than when standing still or walking without the tourniquet, but in certain instances there are different degrees of improvement with the tourniquet at different levels (Fig. 2-A, B, C, D, E, F.).

The interpretation is as follows: If there is greater improvement (less prominence) in the varicosities below the tourniquet when the tourniquet is around the lower third of the thigh than when it is around the upper third, it is evident that not only is there a retrograde flow from the deep to the superficial system through the main opening of the internal saphenous, but that there is also a reflux through communicating veins below the level of the fossa ovalis (Fig. 3). If a maximum improvement occurs when the tourniquet is at the highest level, that is, around the upper end of the internal saphenous (Figs. 4 and 5), and there is no further improvement when the tourniquet is around the middle third or around the lower third of the thigh, then only one source exists for retrograde flow into the superficial system of veins and that source is through the main opening of the internal saphenous into the femoral (Figs. 4 and 5). There is never a greater diminution in the size of the varicosities when the tourniquet is in the upper third than when it is in the lower third of the thigh. It does sometimes happen that the veins *above* the tourniquet, when it is around the lower third, are more prominent than the same veins when the tourniquet is around the upper third. In severe cases this is expected and does not vitiate the test. The test depends upon the condition of the varicosities below the tourniquet.

In interpreting the test, Grade IV improvement means complete or practically complete disappearance of the varices; Grade I, slight; II, moderate; and III, marked improvement. Of course, improvement indicates diminution in the pressure in the veins and in some instances where the vein walls are extremely thick the improvement may be detected more accurately by palpation then by vision. The improvement is recorded for each level. If the improvement on the right leg is Grade IV in the upper third and Grade IV in the lower third (Figs. 4 and 5), ligation at the highest level will accomplish complete obstruction to the reverse flow of blood. If in the same individual the other leg shows a Grade II improvement with the tourniquet in the upper third, Grade III in the middle, and Grade IV in the lower third (Fig. 2), then there must be incompetency not only of the valves in the saphenous vein but also of the valves of the veins communicating between the deep and superficial systems of the thigh (Fig. 3). Though high ligation will suffice in the right leg of this patient it will be insufficient to stop the retrograde flow in the left leg. Something additional must be done. It is not feasible to ligate, independently, each communicating vein as was attempted by deTakáts and Quillian.[4] This converts the operation into a major procedure and extirpation of the veins by any of the described methods has been discarded because of the severity of the procedures and because of the mortality. We believe, because of our experience and that of others, that low ligation alone is not

BEFORE TREATMENT

COMPARATIVE TOURNIQUET TEST



Tourniquet high | Midthigh | Lower thigh

APPEARANCE AFTER LIGATION

After high ligation | After low ligation | One month after ligations

FIG. 2.—Enlargements from moving picture. (A, B. C.) Patient before treatment, showing huge varicosities in the left leg, some on the right. (D, E, F.) The improvement in appearance of varicosities during the comparative tourniquet test. D, is walking with the tourniquet high; E, around the middle of the thigh; and F, around the lower third of the thigh, all sufficiently tight to compress the superficial circulation. Notice that the prominence of varicosities is less marked with the tourniquet around the middle and lower thirds (E, F.) of the thigh than when the tourniquet is around the upper third as in D. The valves of the communicating veins in this thigh are thus shown to be incompetent. G, the patient ten days after ligation and section of the internal saphenous at the fossa ovalis. H, patient ten days after an additional low ligation in the lower third of the thigh. I, patient one month after completion of high and low ligation of the left saphenous vein and high ligation of the right saphenous vein.

sufficient because in a high percentage of cases recurrences readily take place through collaterals subsequently.[5] If high ligation is performed to prevent recurrences, low ligation should also be made in these instances to completely obstruct the retrograde flow from the incompetent valves of the com-

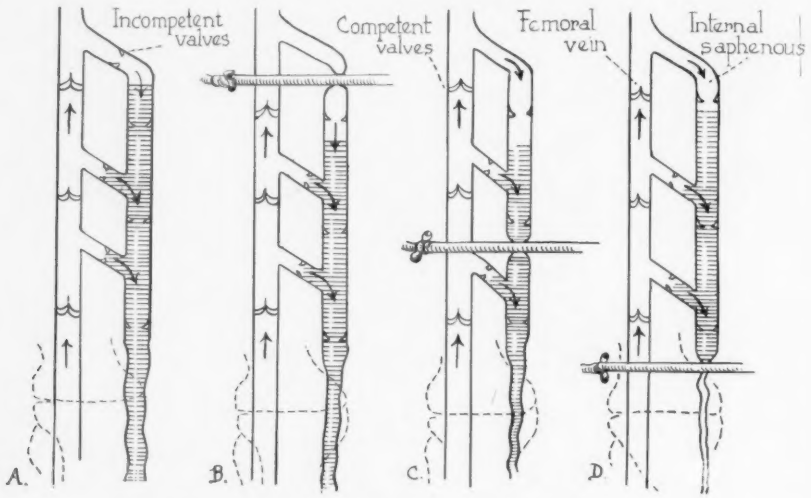


FIG. 3.—The physiology involved in the comparative tourniquet test in the left leg of the patient shown in Fig. 2; that is, when the valves of the communicating veins as well as of the internal saphenous are incompetent. When the tourniquet is high, it stops retrograde flow through the internal saphenous, but there is an abnormal flow from the deep to the superficial systems below the tourniquet through the communicating veins, and only when the tourniquet is below the lowest communicating vein with incompetent valves, as in D, is there collapse of the varicosities.

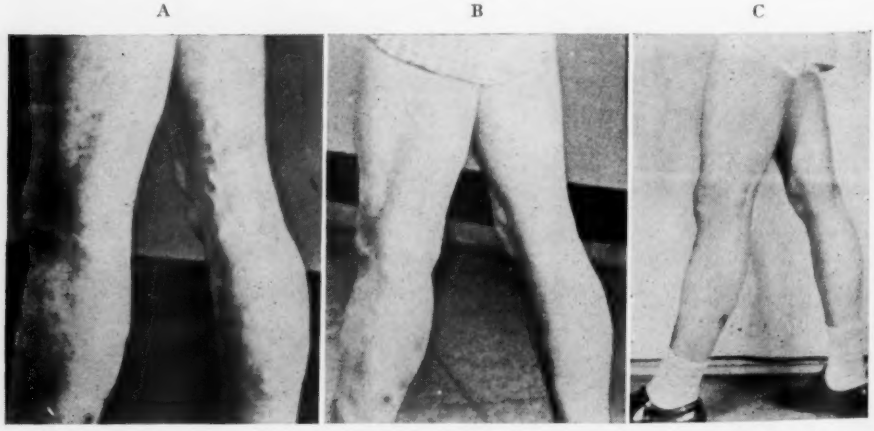


FIG. 4.—Enlargements from moving pictures. Same patient as in Fig. 2. (A) the varicosities of the right leg before treatment. (B) before treatment the patient walking with the tourniquet high on the thigh. The varicosities have entirely disappeared, thus showing that although the valves of the saphenous vein are incompetent, those of the communicating veins are competent and high ligation alone is sufficient to interrupt the retrograde flow from the deep to the superficial system. (C) ten days after high ligation and section of the right internal saphenous vein.

municating veins. It is true that high and low ligations do not preclude the possibility of recurrences through collateral channels around the lowest transection and ligation, but such a possibility is more acceptable than the complete removal of the saphenous vein because the latter is a more formidable operation with a probable, similar incidence of recurrence, and a probable, greater risk (Table I). "Probable" is used advisedly because of the difficulty of estimating recurrences and mortality from available statistics.

In rare instances the improvement with the patient walking and with the

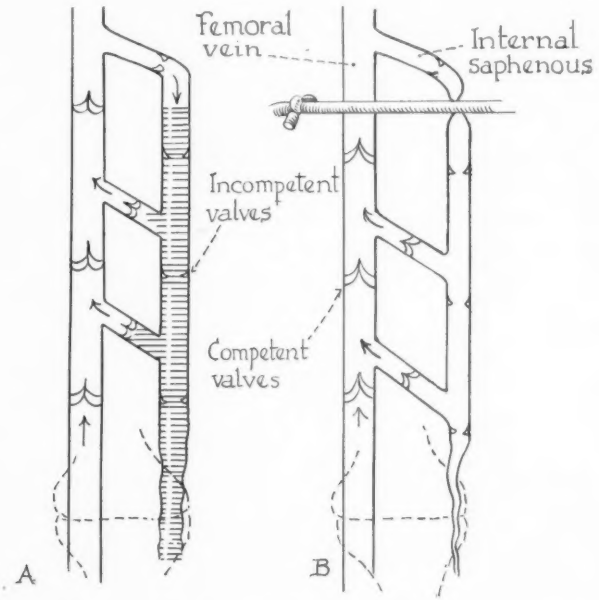


FIG. 5.—Physiology involved in the right leg of the patient shown. When the tourniquet is placed high there is complete collapse of the varicosities since the valves of the communicating veins are competent and since retrograde flow which is occurring through the saphenous vein alone is abstructed. (Compare with Fig. 3.)

tourniquet around the thigh is not complete; that is, cannot be graded IV with the tourniquet around even the lower level of the thigh. There still must be a leak below this tourniquet and this is either directly through the external saphenous system from the popliteal (usually when the external saphenous system in varicose it is due to its connection with the internal saphenous) or through the communicating channels between the deep and superficial systems of the calf. These two sources may be differentiated by putting a tourniquet around the leg below the knee and at the upper end of the external saphenous vein. If reverse flow is occurring through the external saphenous directly from the popliteal, further improvement of the veins of the leg is found when the tourniquet is placed around the upper end of the external saphenous. We have encountered this condition only rarely. Leakage through the communi-

cating veins of the calf (very rare) from the deep to the superficial systems will not be retarded when the tourniquet is placed around the leg below the knee.

The comparative tourniquet test[1] combines the advantages of other tests localizing accurately the veins with incompetent valves. It gives the following information:

(1) Whether the valves of the internal saphenous vein are incompetent.

(2) Whether the valves of the deep veins communicating between the deep and superficial system are incompetent, and where they are incompetent.

(3) Whether there is a direct leak from the popliteal vein into the external saphenous vein.

(4) Whether the communicating veins and the deep veins are patent.

The use of this test safely permits the abrogation of all the other tests except the Trendelenburg-Brodie. The Trendelenburg-Brodie test, by noting the rapidity with which the blood rushes into the varicosities when the pressure is released, gives a better idea of the degree of incompetence of the valves. The doubly positive reaction of the Trendelenburg-Brodie test is not so reliable in detecting incompetence of the valves of the communicating veins as is the comparative tourniquet test. In a group of varicose extremities we found the valves of the communicating veins to be incompetent in 20 per cent by the doubly positive reaction of the Trendelenburg-Brodie test, and in 33 per cent by the comparative tourniquet test in the same group of extremities.[5] Moro,[6] in 1910, found that 55 per cent of 42 cases had retrograde flow not only through the main opening of the saphenous but also through the communicating veins, basing his conclusions upon the recurrences he had after the Trendelenburg operation and the presumption that recurrences meant retrograde flow through the communicating veins, which of course they do not invariably indicate. However, this is the only other estimate we have found besides ours of the relative percentage of leaks through the main opening of the saphenous and through the communicating veins as well.

Historic Notes on the Operative Treatment of Varicose Veins.—Numerous operative procedures have been advocated for varicose veins. It is difficult to evaluate, impartially and correctly, the comparative results of these different methods. The following are, however, among the noteworthy contributions:

Schede,[7] in 1877, described one of the first attempts to perform an operation which would be acceptable from the standpoint of completeness of cure, absence of recurrences, and untoward results. He used principles which had already been employed, but used them much more extensively than formerly. He ligated and sectioned the long saphenous vein in the lower third of the thigh. In those cases in which the wall of the veins was thin and in which, because of the thinness, it would be difficult to separate the vein from the perivenous structures, he used percutaneous ligation. He passed catgut sutures through the skin and under the varicosities in many places and tied the

sutures over a rubber tube the thickness of a finger. He has used as many as 30 ligatures in a single case. Of course, there were many recurrences and this procedure gained no favor.

Madelung[8] described, in 1884, a procedure which consisted of complete excision of the long saphenous and varicose radicals and ligation of the remaining stumps through a long incision on the thigh and the leg. The Madelung operation has been one of the most popular of the radical procedures for varicose veins. It has the disadvantage, however, of being an extensive operative procedure, requiring hospitalization and being attended with a mortality of approximately 0.7 per cent from pulmonary embolism.[9] The principle of the operation is good but has the same fundamental objective as other procedures described at the beginning of the present century (Keller's,[10, 11] Mayo's,[12] and Babcock's[13]) operations, in all of which the vein is removed. In the same article in which Trendelenburg described a test for reversal flow of blood in the long saphenous system, he advocated ligation of the saphenous vein and section of it, but the point of election for him was not high on the vein but where it was prominent in the middle of the thigh. Perthes[14] reported results from this procedure and found recurrences in 22 per cent.

In the early part of the nineteenth century several important advances were made in the treatment of varicose veins. Tavel,[15] in 1904, suggested the treatment of varicosities by a combination of ligation and injection. If spontaneous thrombosis did not occur within 24 to 48 hours after low or high ligation of the long saphenous vein in the thigh, he injected the vein with 5 per cent phenol. Ligation and section alone resulted in thrombosis in only seven of 25 cases. He thought that artificial thrombosis would reduce the percentage of recurrences following ligation. In 1912, he[16] reported 50 cases which had been treated by this method. Though Tavel used the ligation and injection treatment with a period of time intervening, to Schiassi,[17] belongs the credit of introducing simultaneous injection at the time of ligation. Schiassi ligated the long saphenous just above the knee, but when he sectioned the vein he introduced an olivary-tipped glass cannula with an adaptor fitted to a syringe, and injected 30, 40, or 50 cc. of a solution containing iodine Gm.i, potassium iodine grain i, and distilled water 100 cc. into the distal stump. Modifications of this method have been employed widely throughout the world and it is increasing in popularity. Excellent results have been reported from its use by Mazzini,[18] Foa,[19] Putzu,[20] and Schiassi.[21] Nobile[22] modified Schiassi's method by injecting the saphenous vein distally just below the groin and permitting the solution to flow out of the open vein above the knee. Unger[23] modified this method by introducing a ureteral catheter into an incision high in the internal saphenous vein, and as the catheter was slowly withdrawn 1 to 2 cc. of 20 per cent sodium chloride or a sugar solution were introduced for every 5 to 10 cm. of vein.

To return now to an earlier period and to the development of a different type of treatment of varicose veins, one finds that several ingenious instruments and methods were devised for complete removal of the varicosed long

saphenous vein without the necessity of making a long incision as used by Madelung. Keller,[10] in 1905, described removal of segments of vein by passing a wire loop through the lumen, cutting the vein at a distance lower down and tying the tip of the obliquely severed vein to the wire loop. The wire was then withdrawn, the vein segment inverted, and dragged out through its own lumen. He[11] later added mass transfixion of tissues in the region of the vein bed after extraction of the vein. In 1912, he reported 33 cases in which the results were all satisfactory.

In 1906, C. H. Mayo[12] described an instrument for enucleating the vein through a small incision. It consisted of a small ring on a long handle. The incision was made low over the vein and the proximal end of the severed vein was threaded through the ring, and by forcibly shoving the instrument up the tautly stretched vein it was torn from its surrounding connections up to another level where an incision was made and the segment was detached. The remaining stump of the varicose vein was ligated. In the following year, Babcock[13] introduced a modification of the Keller method. Through an incision in the vein he introduced an acorn-tipped guide and passed it through the vein, and at the distal end another incision was made. The vein was severed and the distal end of the segment tied to the tip of the guide. The guide was then withdrawn, the vein with it being pleated on the handle of the guide. The disadvantage of these measures was that there were left many large, lacerated communicating veins in which thrombi were likely to form with the possibility of extension into the deep venous system.

In 1908, Friedel[24] described an operation that was devised and used by Rindfleisch, and which eventually proved to be one of the most atrocious crimes a heavy handed surgeon even inflicted on his patients. The operation which fortunately was reserved for severe cases of varicosities consisted of excision of the internal saphenous vein in the thigh and a spiral incision through the skin and subcutaneous tissue down to the deep fascia, beginning at the knee, encircling the leg four to seven times, and ending at the foot. The bleeding superficial veins were ligated and the wound was packed open, making a deep gutter, which necessitated healing by second intention. Friedel[24] reported seven cases with two recurrences. Meyer,[25] in 1914, reported 42 per cent permanently healed cases and, in 1924,[26] 28 cases with the following results: One death from sepsis, and three other deaths within a year, the cause not given. Of ten cases which he followed for from one to ten years, only seven had a satisfactory result, but as the picture from Friedel's article showed, the optimum result appears atrocious. Fortunately, only Rindfleisch's and Bircher's clinics found this operation acceptable enough to give any expression of approval.

Tavel,[15] in 1904, and Homans,[27] in 1916, called attention to the advisability of ligating the internal saphenous high above any of its collaterals in order to prevent recurrences. This very important point is still not sufficiently appreciated. In cases in which the Trendelenburg test is doubly positive, indicating incompetency of the valves of the deep communicating vein, Ho-

mans[27] recommends extirpation of the vein. deTakáts,[28] in 1930, suggested that ligation of the saphenous vein could be done as an ambulatory procedure, which has proved a noteworthy contribution. From our own experience and from an exhaustive review of the literature, we believe that thrombus propagation and embolus are greatly diminished and prevented by the patient being active. We have found no deaths from embolus recorded where this method has been properly used. Faxon's[29] patient died, but the patient had been put to bed.

Modern Treatment.—A variety of measures are used for treating varicose veins of the lower extremity, and the indications for selecting a method or combination of measures for a particular case vary because of the many factors involved. The following methods, either because of their efficiency or because of various reasons why they should not be used, are worthy of discussion:

(1) Preventive treatment—rest, external support.
(2) Conservative treatment:
  (a) Rest and elevation
  (b) Elastic supports
  (c) Unna's paste boot
(3) Injection treatment—use of sclerosing solutions intravenously without operation.
(4) Operative treatment:
  (a) Extirpation
    Madelung's operation
    Mayo's operation
    Keller-Babcock operation
  (b) Schede operation
  (c) Ligations—single or multiple
  (d) Ligation and simultaneous or preliminary or subsequent injection of sclerosing solutions.

Selection of the proper treatment for the individual case not only calls for considerable knowledge and judgment, but should evoke a fairness in evaluating the different measures rather than persistence in blind adherence to a particular type of therapy.

Contraindications to Active Treatment.—In considering the applicability of a measure a number of points must be weighed, among the most important of which are the age of the patient, the existence of pregnancy, the presence of any debilitating disease, the existence of any severe impairment in arterial blood supply to the part, the study of previous or coexistent phlebitis, and the presence of pelvic tumors or other mechanical obstruction to venous flow. The above conditions may be actual contraindications to the active treatment of varicose veins; there are none to the conservative treatment, which consists of rest and elevation or external support alone.

(1) *Advanced Age.*—Senility, in which the mental or physical condition of the patient promises less from alleviation of varicosities by active measure

than by a simple compression bandage either in point of time (life expectancy) or in faculty of appreciation (the mental ability to do so), may be a contraindication to the active treatment of varicose veins.

(2) *Pregnancy* is more an indication for conservative treatment than it is a contraindication to active treatment. Better expressed, it is an indication for delayed active treatment. The facts leading to this conclusion are: Varicose veins appear or are made worse by pregnancy. Frequently the patients first present themselves for treatment during pregnancy, and it may appear difficult from the intrinsic standpoint of the physician alone to instruct that patient concerning the conservative measures and advise her to return later after the puerperium for the actual treatment of the varicosities. Some of these patients will never submit to active measures later, though such treatment may be advisable, and this small percentage is perhaps the only argument for immediate active treatment. On the other hand, since varicose veins become worse during pregnancy, there is the probability that a goodly number of patients treated at this time may have recurrences even before parturition. Some few patients will have such a marked abatement of varicose veins after the puerperium that they are practically normal and need very little active treatment. In these, the conservative measures (supportive bandages or stockings) are, indeed, preventive measures which in pregnancy also consist of rest in bed and elevation of the legs during the middle of the day. The records of the Hutchinson Memorial Clinic of Tulane University School of Medicine show 285 cases of varicose veins diagnosed at the clinic between September 19, 1932 (when it opened) and January, 1936. There were 9,233 patients registered during that time. Thus one in 32 admissions had varicose veins (3 per cent). One hundred fifty of these varicose vein patients were seen in the Department of Obstetrics alone and did not come to surgery, though others did from that department. There was a total of 1,419 pregnant women seen by the Department of Obstetrics during that time. Thus approximately 10.6 per cent of pregnant women showed varicose veins, and 53 per cent of varicose vein cases were pregnant. Pregnancy was the main reason these 150 patients came to the clinic and varicose veins was only an associated condition. Yet this group represented 52 per cent of the cases of varicose veins registering during that period, and few of these had severe enough varicosities after parturition to make them seek treatment for their veins. The inference is striking; *i.e.*, supportive treatment but not active during pregnancy for this group; active treatment for those that need it in the puerperium. Occasionally, in severe cases, it may be advisable in the early months of pregnancy to use active measures to treat the varicosities.

(3) The presence of certain *debilitating diseases* is a contraindication to the active treatment of varicose veins. It may seem needless and pedantic to mention that patients with metastatic carcinoma or other diseases in which the life expectancy is short should have only conservative treatment for varicosities. Conditions such as severe anemia, diabetes, cardiac affections and

pulmonary disease should be corrected or under absolute control before active treatment of varicosities is undertaken.

(4) The existence of any severe *impairment to the arterial blood supply* may be a contraindication to active treatment of varicose veins. Ligation of the saphenous vein for varicosities may greatly improve the circulation to an extremity in which it is impaired not only by varicose veins but also by arterial sclerosis, and the extremity may be benefited by ligation. On the other hand, in the extremity in which the blood supply is very deficient, any accident such as infection or excessive thrombosis may precipitate a disaster, the possibility of which causes one to hesitate to employ any radical treatment. The injection treatment is possibly even more dangerous to these individuals than high ligation alone, because the injection of sclerosing solution may precipitate excessive thrombosis, causing reaction and edema with which a poorly nourished extremity could not adequately contend. Even with ligation, about 25 per cent of the cases will have a peripherally propagating thrombus which may also be dangerous for similar reasons. Therefore, extreme caution should be employed for cases affected with arteriosclerosis, and because of the nature of thrombo-angiitis obliterans active treatment would always be extremely dangerous. In considerable experience with both conditions, we have rarely seen thrombo-angiitis obliterans and varicose veins associated.

(5) The history of *previous or coexistent phlebitis* may be in the former, and is in the latter instance a contraindication to the active treatment of varicose veins. Active phlebitis of the deep veins is a contraindication to active treatment being directed to the care of varicose veins. Infective thrombophlebitis may be disseminated by active treatment (Hanschell[30]). How long one should wait after an attack of phlebitis of the deep veins before the active treatment of varicosities is under taken is a debatable question. Six months is a minimum period. Where a deep phlebitis has left a residual obstruction to the deep system, which is detectable by the comparative tourniquet test, it is not permissible to obstruct the superficial system either by ligation or injection. However, an obstruction to the deep veins following a recent phlebitis may clear up after a sufficient length of time (six months to two years).

(6) *Tumors of the pelvis* or other mechanical obstruction to the return venous flow, even if not an actual contraindication to the active treatment of the varicose veins, should be corrected before the varicose veins are treated. In the interval conservative measures may be employed.

Selecting the Type of Treatment for the Case.—In selecting the type of treatment best suited for a case we will consider, individually, the four categories of treatment and the type of case which should be managed by each method.

(1) *Preventive Treatment.*—Preventive treatment is most frequently indicated in pregnancy. The obstetrician should instruct patients who have

any predisposition to varicose veins in the preventive measures. These are rest in bed in the midday or midmorning and midafternoon for at least a half hour with the legs slightly elevated. The patient should wear bandages or elastic stockings if varicosities are present.

(2) *The Conservative Treatment* is merely supportive. Presumably the existence of varicose veins is indication enough for therapy, but because of contraindications active treatment is not always feasible. Such cases are those in which age, severe concomitant diseases, arteriosclerosis, *etc.*, make active treatment inadvisable and cases in which pelvic tumors, phlebitis, pregnancy, make the delay of active treatment advisable.

Technic of Conservative Measures.—Bandages consisting of cotton fabric, woven so that there is some elasticity, or silk with fine elastic threads incorporated, are used. There are several varieties. Bandages are usually five yards in length and vary in width. Three and four inch widths are the best sizes. Proper application consists of one turn about the ankle, then one or two turns around the foot, returning to the ankle and wrapping spirally up the leg to just below the knee, wrapping each previous turn one-half the width of the bandage. In some instances two bandages are necessary for one leg, the additional one beginning below the knee and continuing up the thigh. The bandages are applied in the morning and removed at night before retiring. The commonly employed "Ace" bandage is excellent for this purpose.

Elastic stockings generally contain some rubber. They may be effectively used in some cases where the conservative treatment is indicated. The heavy ones have a tendency to roll into creases. For prolonged use in weather which is not uncomfortably hot they are probably more satisfactory to the patient than bandages. There are several varieties and makes, heavy mercerized cotton and rubber or heavy silk and rubber. One of the best varieties, the one we prefer, is the "Lastex," (Bauer & Black). It is thin but effective and scarcely shows under other stockings. The preferable type contains heel and toe, and may be a short one stopping below the knee or the longer stocking which goes to midthigh. Doctor Scholl's is another satisfactory one.

Unna's paste boot is indicated in the preliminary treatment of varicose ulcer, not in uncomplicated cases of varicose veins where bandages and elastic stockings better serve the purpose.

Rest and elevation of the lower extremities are adjuncts to supportive measures. The patient is instructed to recline at midday or in midmorning and midafternoon and elevate the legs slightly on pillows, resting at least one-half hour each period. This is especially indicated in those cases complicated by edema or ulceration.

(3) *Treatment by the Injection of Sclerosing Solutions Only.*—The selection of cases for treatment by the injection of sclerosing solutions, and the use of this measure without operative treatment, involves the difficult problem of comparing the value of this method with the combination of an operative measure and the injection of sclerosing solution. This comparison must take

into consideration the late as well as the immediate results, the mortality, the ease of administration, and relative discomfort to the patient.

TABLE I

RÉSUMÉ OF STATISTICS RELATIVE TO MORTALITY, RESULTS AND RECURRENCES (COMPILED FROM THE LITERATURE)

Injection Treatment Only

Author	Solution	No. of Cases	Cases Followed	Percentage of Recurrence	Time of Follow-Up	Emboli	Fatalities
Howard, Jackson, and Mahon,[42] 1931	Sodium chloride 20%	66	52	98%	1 yr. or more	1	0
Faxon,[43] 1933	Quinine urethane	613	314	63%	Avg. 1.4 yrs.		
Kettel,[44] 1932			225	86.6%	5 yrs.		
Levi,[45] 1927–28	Glucose 66%	60				1	0
Forestier,[46] 1928				15%			
Frankel,[47] 1929		800		8 to 10%		0	0
Logefield and Dahlstrom,[48] 1929	Invert sugar, sodium chloride	96		2%	6 mos.		
Meisen,[49] 1927	Sodium chloride 10% and sodium salicylate 25%	500		0	9 mos.		
Kilbourne,[28] 1929	Various	Collected cases		6%			1 in 5000
Woolsey and Millzner,[50] 1929	Sodium salicylate 20%, quinine and urethane	150		6%			
McPheeters and Rice,[21] 1928			53,000 collected				7
Schmier,[51] 1930	NaCl, Na salicylate, Quinine HCl and urethane, dextrose	3,000				0	
Scott,[52] 1930	Quinine and urethane	10,000				0	0
Cooperman,[53] 1929	Sodium salicylate 40%	64		18%	3 to 5 mos.		
Keller,[54] 1929	Sodium chloride 20%	1				1	0
Hansen,[55] 1931		107		49%	1 to 3 yrs.		
Kettel,[56] 1931		60,000 collected				10	20 deaths from emboli and other causes
Mundt,[57] 1930							1 death from mercury poisoning
Pennoyer,[58] 1930	Sodium salicylate quinine urethane	218	48	8%	18 mos.		
Silverman,[59] 1931	All	Review literature				In entire literature 19. Adds 1	In entire literature 14. Adds 1
Ochsner and Mahorner,[5] 1937	Sodium morrhuate		25	57.2%	6 mos. to 3½ yrs.		

TABLE II

RÉSUMÉ OF STATISTICS RELATIVE TO MORTALITY, RESULTS AND RECURRENCES (COMPILED FROM THE LITERATURE)

Operative Treatment

Author	Method	No. of Cases	Cases Followed	Percentage of Recurrence	Time of Follow-Up	Emboli	Fatalities
Howard,[22] 1934	Ligation and injection distal stump	68	58	23%	1 yr. to 29 mos.		
Colt,[26] 1928	Keller-Babcock	94	22	18%	4 to 6 yrs.	0	0
Putzu,[20] 1919	Schiassi	32	32	19%			0
Siebner,[27] 1929	Multiple transfixions, Schede	20	15	60%	6 mos. to 2 yrs.		
Keller,[11] 1924	Extraction by inversion	33	33	0	1 yr.		0
Tanner,[28] 1927	Extraction by inversion, Keller-Babcock	52	29	18%	Avg. 22 mos.		0
deTakáts and Quillian,[4] 1933	Ambulatory ligation	200	60	3%		0	0
Müller,[24] 1928	Simple ligation, excision, ligation and injection	100	51	46%	At least 9 mos.	2	1 (1%)
Kilbourne,[25] 1929	Various operations	14,000		30%			0.4%
Tavel,[16] 1912	Ligation and injection	50	50	12%			0
Miller,[23] 1906	Trendelenburg	98 legs	41	22%	6 mos. to 10 yrs.		
Miller,[23] 1906	Schede	19 legs		66%	6 mos. to 10 yrs.		
Berntsen,[9] 1927	Trendelenburg	83	83			8.4%	1.2%
Berntsen,[9] 1927	Extirpation	376				7.2%	0.7%
McPheeters and Rice,[21] 1928	Collected operations by various surgeons	6,771	6,771			72	35 (0.53%)
Faxon,[29] 1934	Ligation and injection	118				1	1
Perthes,[14] 1895	Ligation mostly in lower third of thigh	63	41	22%	5 mos to 9 yrs.		
Ochsner and Mahorner,[5] 1937	High ligation only plus injection	11	11	18%			
Ochsner and Mahorner,[5] 1937	Ligation, midthigh only	12	12	50%			
Bange,[41] 1925	Ligation and multiple subcutaneous discissions	100					1

Tables I and II present a résumé of the statistics relative to mortality, results, and recurrences compiled from the larger series of cases reported in the literature. It will be noted in the report of authors upon series of cases treated by the injection method only, that the recurrence rate is reported from zero in nine months and 2 per cent in six months, to 98 per cent in cases followed for a longer period. In our experience[5] the injection treatment

has been followed by recurrences in 60 per cent. As far as the mortality is concerned, McPheeters and Rice's[31] figures of seven deaths in 53,000 collected cases is proof enough that the injection of sclerosing solutions for varicose veins is a relatively safe procedure. The reported results from operative methods show recurrences from zero to 66 per cent. Ligation combined with injection treatment showed recurrences as follows. Tavel,[16] 12 per cent; Putzu,[20] 19 per cent; Howard,[32] 23 per cent; R. Miller,[33] 22 per cent, and deTakáts and Quillian,[4] 3 to 5 per cent. Operative procedures other than those grouped as ligation alone, including excisions, gave recurrences as follows: Müller,[34] 46 per cent; Kilbourne,[35] 30 per cent; Colt,[36] 18 per cent; Siebner,[37] 60 per cent; Keller,[11] none; Tanner,[38] 18 per cent, and R. Miller,[33] 66 per cent. As regards the mortality for operative procedures, Müller[34] reported 1 per cent mortality in 100 cases; Kilbourne,[35] 0.4 per cent mortality in 14,000 cases, and Berntsen,[9] 0.7 per cent mortality in 376 patients. We have had no deaths in our experience in over 100 ligations with simultaneous or subsequent injection of sclerosing solutions, all of which were managed by ambulatory convalescence. We have found no deaths reported after ligation and injection of sclerosing solutions when an ambulatory convalescence has been enforced. On the other hand, Domanig[39] encountered pulmonary embolism twice, with one fatality, in 43 cases treated by ligation and section and injection of sclerosing solution into the distal lumen, when the patients were kept in bed for ten days.

Although these statistics are very significant, they are not as conclusive in their directions as one would wish them. The wide ranges of reports, if not confusing, at least weaken confidence in the following conclusions which express only in a general way the trend of the statistics; namely, operative treatments such as excision and ablation have a mortality of from 0.4 per cent to 1 per cent, which is far higher than the mortality by the injection treatment. Simple ligation apparently has less risk, which has been shown by our experience, in which ambulation was enforced during convalescence, and by the absence of reports in the literature of deaths when ambulatory regimen was used. Enforced walking during convalescence is a distinct advantage and reduces the danger of pulmonary embolism. Any method which has from 0.5 to 1 per cent mortality for varicose veins must be looked upon with disfavor because of the remarkably low mortality following the injection treatment. On the other hand, the trend of the statistics in recent series of varicose veins treated by injection alone shows an extremely high percentage of recurrences; far more undoubtedly than the incidence of recurrence from ligation and the use of sclerosing solutions.

For these reasons, and our personal experiences, we have reached the following conclusions regarding operative measures with or without the injection treatment versus the injection treatment alone: Procedures such as extirpation and enucleations with strippers or other instruments are too severe and extensive, necessitating the patient having a convalescence in bed, which predisposes to embolism, and a mortality too high to justify their em-

ployment. Ligation combined with the injection treatment is a relatively simple and very safe procedure, and is followed by less frequent recurrence than the injection treatment alone, which is, apparently, quite safe. We take the following attitudes in selecting the cases for these types of treatment:

For the injection treatment alone we select:

(1) Early cases with small varicose veins of the calf or lower leg, which, clinically, do not show a positive Trendelenburg-Brodie phenomenon; even if a recurrence follows, there has at least been a temporary benefit, and if it becomes necessary other measures may be employed later.

(2) Those cases which are suitable for operative treatment and refuse ligation.

(3) Certain cases where the psychologic approach to operation seems best accomplished by an initial and partial injection treatment. In certain instances in studying the case it is surmised that if an operation is immediately advised the patient will not only refuse the operation but also any active treatment, because since the former, which she does not want at the moment, was presented first, everything else seems second best and the wary patient is frightened away from what might be the best procedure for her.

For operative treatment with the combination of the injection of sclerosing solutions, we select all cases with moderate or severe varicosities in whom there are no contraindications to active treatment. As far as the type of operative treatment is concerned we discard, as carrying too high a mortality and being too severe, the complete excision of the saphenous vein and its radicals (Madelung, the Mayo operation, and Keller and Babcock extractions). These radical procedures carry no more promise of permanence of results than ligations and transactions combined with the injection of sclerosing solutions. Schede's operation is followed by many recurrences, so many in fact, that it is not worthy of serious consideration.

(4) *Technic of Operative Treatment.*—Our preference for the high ligation and transection of the internal saphenous vein, just before it enters the femoral vein, and above any of its tributaries, with the simultaneous injection of a sclerosing solution into the distal lumen, and in certain instances, as indicated by the comparative tourniquet test, additional ligations and injections below this level, has been stated.

The technic of ligation of the saphenous vein high is as follows: The patients need no special preliminary preparation; they do not have to fast. The patient is placed in dorsal decubitus. The inguinal and pubic region and adjacent upper part of the affected thigh is shaved. The skin of this area is cleansed with ether and painted with some suitable antiseptic. Draping the field is important. A folded sterile towel is placed in the crotch, protecting the thigh from the genitalia and pubic region. The surface sheets and towels are so spread that an operative field is left which exposes the middle and inner part of Poupart's ligament and the adjacent upper part of the thigh from a line outside the middle to the recessing inner border of the thigh. It is important to have the field large enough to palpate the femoral artery, and to

have adequate room to work mesially because the course of the saphenous vein is sharply posterior from its termination at the saphenous opening. The femoral artery is palpated as it passes under Poupart's ligament. The fossa ovalis is located two fingerbreadths mesial to this and one fingerbreadth below Poupart's ligament, or below the level of the spine or pubis. A longitudinal incision gives a better exposure than the transverse (Fig. 6). With a longitudinal incision, the collateral channels at the upper end of the saphenous vein are exposed more easily and with less dissection. The important tributaries are the external pudendal, the superficial circumflex iliac, the superficial epigastric, thoraco-epigastric, and the external superficial femoral vein (Fig. 7). Anomalies of these vessels are very common. They sometimes enter directly into the femoral vein, two or more of them sometimes forming a common stem before emptying into the saphenous vein. It is very important to see the termination of the following tributaries: The external pudendal, the external superficial femoral, and the external circumflex iliac. The external pudendal should be above the area of injection of sclerosing solution into the long saphenous, because it is not desirable to have any of the solution go into veins of the labia majora or the scrotum, especially if these veins are not varicosed, and at the same time it is desirable to interrupt the flow in the external pudendal, particularly when it is varicosed, because collaterals from this vein into the internal superficial femoral veins are possible channels for reestablishment of a retrograde circulation and thereby predispose to a recurrence. On the other hand, it is desirable to inject the sclerosing solution into the external superficial femoral vein, either by injecting it into the great saphenous vein above the termination of this trunk or into the separately ligated external superficial femoral vein. It is rare, even in severe cases, for the internal saphenous vein to be visualized at its upper end, because it is so deep and is covered by fat and skin. Even palpation may not localize it and Schwartz's test[29, 40] is infrequently of value.

The incision begins at Poupart's ligament and 2.5 cm. mesial to the line of the femoral artery (Fig. 6). The latter landmark is appreciated by palpating the pulsating artery as it passes under the middle of Poupart's ligament. The incision continues for a distance of about 5 cm. straight downward and slightly inward, diverging from the line of the artery. The vein is deep in the subcutaneous tissue, of considerable thickness here, especially in women. One can incise through this without danger but should be cautious of injuring either the vein or its collaterals. Suspicion of the proximity of the vein may be often inferred before the vein has been uncovered, by a peculiar darkness or blueness showing through the fat. The vein is from 0.5 to 2 cm. in diameter. It is isolated and separated from surrounding tissue, to its entrance into the fossa ovalis and downward for about 3.5 cm. The long saphenous vein is not easily confused with the femoral. It is superficial to the deep fascia—that is, the very thick fascia lata—and if there is any doubt it is well to remember that the femoral artery is lateral and contiguous to the

femoral vein. One will note the external pudendal vein emptying into the saphenous vein from the medial aspect, and the superficial circumflex iliac and the external superficial femoral usually a little higher from the lateral aspect (Fig. 7). The latter veins frequently enter directly into the femoral vein. These may be transacted and ligated separately or if the external superficial femoral is low enough the saphenous vein may be doubly clamped, transected, and ligated above it. The long saphenous vein is clamped near its termination with two small curved hemostats, between which the vein is transected. The proximal stump is then transfixed with No. 2 silk or with No. 1 plain catgut, and ligated securely on one side and then by rotating the clamp the ends are

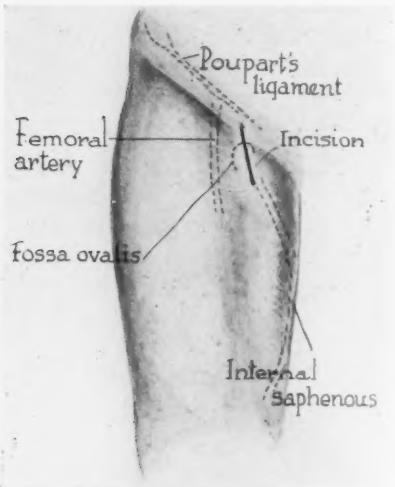


FIG. 6.—Location of the incision for high ligation of the saphenous vein. Two finger-breadths mesial to the pulsating femoral artery, and beginning just below Poupart's ligament; it runs downward and slightly inward.

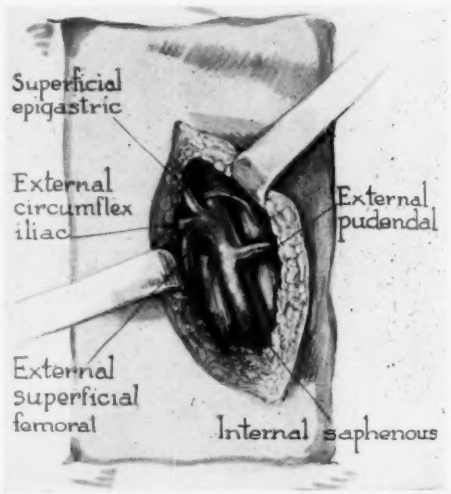


FIG. 7.—Anatomy at upper end of the internal saphenous vein, showing important tributaries which should be ligated separately. In this instance, drawn from the patient shown in Figs. 2 and 4, the superficial epigastric, external circumflex iliac, and superficial femoral veins enter by a common stem at the junction of saphenous with the femoral vein, but they all may enter separately, either at this level or higher or lower. These veins, and the external pudendal, shown should always be ligated and sectioned to obviate recurrences in the collaterals.

brought around the vein and tied again. The vein stump is then ligated again, without transfixing, proximal to the first transfixed ligature on the theoretic grounds that no suture material is exposed in the lumen after secondary ligation, in order not to initiate a thrombus in the free circulation. Otherwise, the transfixing suture may still be exposed to the current of venous blood going directly to the heart. With a small Sana-lok syringe, 2 or 3 cc. of 5 per cent sodium morrhuate (Searle's) or 5 per cent sodium gynocardate are then injected into the distal lumen of the transected vein (Fig. 8). Care must be taken to keep the sclerosing solution from leaking from the vein into the field of operation. This upper end of the distal segment is transfixed and doubly ligated. A thrombus in the segment is desirable. The ends of the cut vein retract several centimeters from each other when released.

The subcutaneous tissue is approximated with No. 2 silk and the skin sutured with dermal.

The patient remains on the table one hour and is then permitted to go home in an automobile, walking to the elevator and car. She is advised to rest for the first few days but not to remain in bed entirely. We insist that she get out of bed and walk around the room every two hours even on the day the operation is performed. She wears a compression "Ace" bandage or an elastic stocking during this period, and after 48 hours, if there is not too much dis-

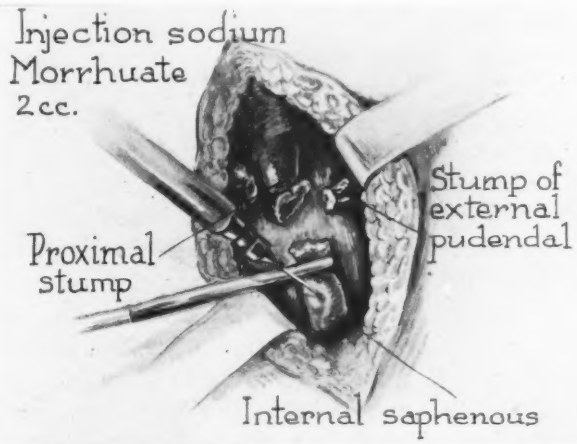


FIG. 8.—After section and ligation of the proximal stump of the internal saphenous vein and its tributaries, 2 cc. of 5 per cent sodium morrhuate are injected into the distal segment. The vein is clamped below this level, transfixed, and ligated.

comfort, the individual is usually fully able to tend to duties. Patients must be reasonable and not stand on their feet for eight hours a day during the first few days after treatment. Frequently a hard palpable vein, which obviously contains a thrombus, can be felt before the patient leaves the table. In approximately 90 per cent of the cases, a thrombus will be found after 48 hours, extending from the operative site to just above the knee in the internal saphenous vein, and in approximately 40 or 50 per cent of instances the thrombus will extend downward into the varicosed radicals of the calf. Not infrequently, however, there will be small ectatic veins on the calf which need to be injected individually ten days or two weeks after the operation.

This completes the treatment in those cases which have incompetence only of the valves of the great saphenous vein, but for that group in which the comparative tourniquet test has also shown that valves of the communicating veins are incompetent something more is advisable in order to interrupt this retrograde flow through the veins communicating between the deep and the superficial systems of the thigh. When a retrograde flow or leak from the deep to the superficial system is occurring below the main opening of the saphenous vein, the communicating veins, which are responsible in this instance, are usually in the thigh, and generally it is not through the communi-

cating veins of the calf or from the popliteal vein through the main opening of the external saphenous into the external saphenous system. If there is a direct retrograde flow from the popliteal vein into the external saphenous system, it is advisable to interrupt this retrograde flow by a separate ligation of the external saphenous vein at the upper end. There are several possible ways of stopping the leaks through the communicating veins. These are: (1) Ligation of each communicating vein individually; (2) extirpation of the internal saphenous and ligation of communicating veins and collaterals; and (3) ligation and transection of the saphenous below the level of all the communicating veins with incompetent valves.

It is not feasible to ligate each communicating vein individually, because it would necessitate exposing the entire length of the internal saphenous vein in the thigh and ligating and sectioning each tributary. Such an operation would become, therefore, a major procedure of as much magnitude as extirpation of the internal saphenous vein by the Madelung method. When a thrombus forms in the internal saphenous vein, which we have described as occurring in the majority of cases after distal injection of sclerosing solution, there is less retrograde flow through this vein from incompetent communicating channels. There is, however, a tendency for this obstruction to disappear, especially when the blood in the venous system is under high pressure. The most feasible remaining procedure, therefore, seems to be an additional transection and ligation of the saphenous vein below all the communicating veins which have incompetent valves. This is done some two weeks after the high ligation of the saphenous on the same side and again 2 cc. of sodium morrhuate are injected into the distal stem of the vein. Apparently it is more important here to resect a sleeve of the saphenous about 2 cm. in length because of the danger of recurrence through the scar.

It is to be recognized, in employing this procedure, that recurrences can take place around the site of ligation through the collateral channels in the superficial system of veins and also that recurrences can take place through the scar. While appreciating this, it is also to be remembered that no method of treating varicose veins insures definitely against recurrence. It seems that the method detailed above will give better permanent results than any of the other methods.

Furthermore, no matter what the treatment is for varicose veins, no attempt is made to reestablish the normal physiology, nor can this be accomplished. In the injection treatment alone, obstruction to the flow is produced by initiating thrombosis in the vessel. With ligation and injection a more definite obstruction is brought about. Excision attempts to remove the pathologic vessels, but it does not reestablish normal physiology.

In those cases which show recurrences the patients must be treated, again selecting the method most applicable to the conditions which they present at the time they apply for treatment of the varicosities. To forestall any concern the patient may have relative to recurrences, they are told that there is no way of predicting in which patients varicosities will again occur, but that there is

such a tendency, and that at least 10 per cent will recur after such treatment. They are assured that varicosities can be corrected again, and that if they never neglect varicose veins they will not develop complications such as ulcer and hemorrhage.

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DISCUSSION.—DR. WM. D. HAGGARD (Nashville, Tenn.).—After this perfect exposition and compelling confirmation, I believe that it is like carrying sugar to New Orleans to add anything. This definite demonstration of what has been happening to us without our knowledge is going to be extremely helpful. Like many of you, I have gone through with all the forms of treatment. We began with circumcision of the veins through the skin (Schede's operation), with ligation of the severed superficial veins with only fair results. Then we employed the extensive vein stripping operation, which was fairly satisfactory. The demonstrations of Doctor Mahorner convince us that our source of error was that we ligated the long saphenous vein too low. In addition to ligation of the vein at the saphenofemoral junction, ligation of the tributary veins is necessary, particularly the superficial epigastric, the circumflex iliac, and the external pudendal vein. The immediate grade injection of sodium morrhuate, and then a few subsequent injections below the knee is curative in practically all cases. If one fails to ligate those veins one is likely to have recurrence. We are all familiar with the disappointing results, by and large, of injection of sclerosing solutions above. I think most surgeons now feel that this simple procedure of ligating not only the long saphenous but those three tributaries, offers the best results. We have used it in a number of cases that have recurred after vein injections, vein stripping and ligation of the saphenous below the junction.

THE REPAIR OF SURFACE DEFECTS OF THE HAND*

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AN ATTEMPT will be made here to illustrate the representative problems that have occurred in a rather large group of surface deformities of the hand. A definite finding has been that free skin grafts have given satisfactory results in a high percentage of patients and in many where the use of a pedicled flap might have been thought necessary. The application of free grafts may require more time at one operation, but the total amount of work may be much less. If the free graft does not give a satisfactory result, then it can be replaced with a flap, but this has not been found necessary in this series.

Where deeper work is going to be necessary—such as nerve, tendon, bone or joint repair, or if these structures are too much exposed—then a pedicle flap containing some subcutaneous fat may be desirable.

A simple, fundamental rule can be deduced: That when the full-thickness of the skin has been lost, even over small areas, in such a kinetic region as the hand, the indication for treatment is to restore this loss as completely and as soon as possible.

One note of warning should be made of the frequent recommendations for certain methods of treatment that "do not leave scars." This is a fallacy if there has been a full-thickness loss, and carrying out the plan of waiting for some application to produce healing has resulted in permanently crippled hands. Frequently, along with this plan, the thumb has been dressed right alongside the index finger with disregard of the position of function.

The repair of tendons and nerves is considered a separate phase in reconstructive surgery of the hand, and one naturally follows the advice of the most consistent workers in this field—extensive reports of which have been made by Kanavel, Koch and Mason.

Fresh Superficial Burns.—A fresh burn of the hand can probably best be managed by open surgical drainage, using wet packs or grease gauze, rather

* In the 1919 edition of Da Costa's Surgery, there is an illustration of a full-thickness skin graft which was accomplished by Dr. George Summers Brown, a former surgeon of Birmingham, Ala., and by Dr. J. M. Mason, for the correction of a burn deformity of the hand. The result of this operation, performed some time before 1910, is excellent, and better than many obtained to-day in single operations for such lesions. As Doctor Brown was a member of the Southern Surgical Association, perhaps nothing could have made him happier than to be present at this Anniversary Meeting, and it is in his memory that I would like to present the following communication.

than sealing the area as with tannic acid or plaster of paris. The open method allows early determination of the depth of the loss and movement of the joints, and, if there has been no full-thickness loss of skin, early healing and return to function can usually be obtained by simple débridement of the dead surface and keeping the hand clean and comfortable. If infection does develop in this type of wound, or if the hand is neglected and left out of the

A

B

FIG. 1.—(A) Laundry burn with full-thickness loss of skin of entire dorsum of thumb, grafted after two weeks. (B) Complete permanent coverage with thick split-graft, after seven months.

position of function, a marked crippling may result from deep fixation of tendons and joints, and possibly from loss of the skin itself from infection.

Fresh Deep Burns.—A full-thickness loss over the back of the thumb that was sustained in a laundry-press is shown in Fig. 1. The wound was gently débrided, and open drainage with wet dressings started. At the end of two weeks the area was covered with a thick, split-skin graft and complete function without deformity has resulted. (Patient cared for by Dr. Gene Bricker, Resident Surgeon at Barnes Hospital.) Another laundry-press loss is shown in Fig. 2, when seen one month after the accident. Gentle débridement (which includes soap and water cleansing and the removal of dead skin), and salt

packs were used; in five days the granulations were carefully cut away, and the entire defect covered with a split-skin graft from the thigh. This patient has been recorded before but is again reported here, after four years, to show that there has been complete and permanent function.

Late Unhealed Burns.—If losses have been very widespread, there may be repeated ulceration and permanent healing may never occur. The plan of restoration in patients with open wounds is to graft these areas first so the region will be clean when the hand is opened for correcting the deformity.

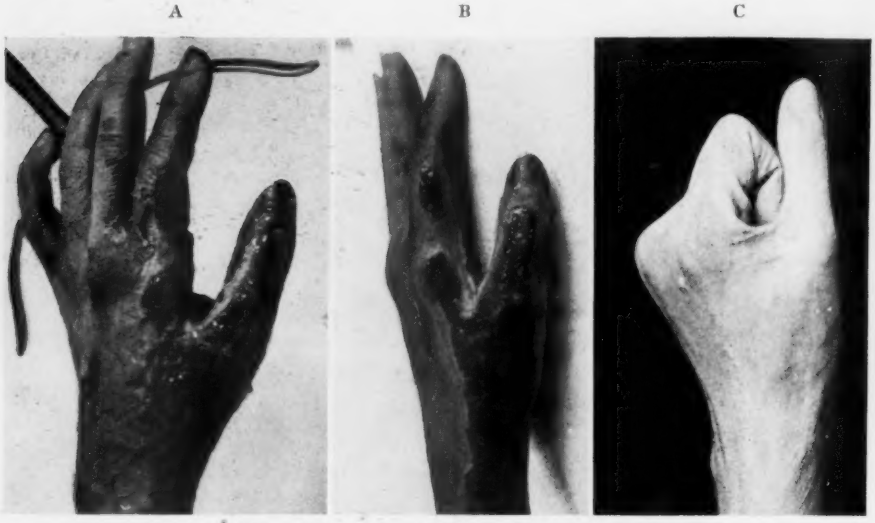

FIG. 2.—(A) One month after laundry mangle injury and burn. (B) Two days later, after gentle débridement and saline dressings. Operation performed three days later, at which the granulations were carefully cut away down to a firm base, and the entire area was covered with a single large, thick split-graft. (C) Complete and permanent function shown after four years.

This type of unhealed lesion after 14 months with complete loss of use of the left hand is illustrated in Fig. 3. The contracture has drawn the thumb out of the position of function, caused a deformity of the joint surface and dislocation of the metacarpophalangeal joint. After the arms were healed with split-skin grafts, then the contracture was carefully opened so the thumb could be put in fairly good position, and the resulting defects were filled with split-grafts. A second releasing operation was necessary, and a direct circumferential wire was put around the metacarpal to hold it out in position while the grafts were becoming fixed. The result is shown in Fig. 3 *B* with the thumb and fingers functioning for the first time since the accident.

Late Deformities Repaired with Free, Thick Split-Grafts.—Many late deformities can be repaired by carefully dissecting the scar so that complete correction can be obtained with little or no tendon exposure, and then covering the defects with thick split-grafts. The patient shown in Fig. 4 is chosen to represent this because of the extensiveness and occurrence of contractures in both hands.

The split-graft is cut one-half to three-fourths the thickness of the skin

deep—if possible, in a single piece large enough to cover the entire area. It is sewed on at about normal skin tension with running horsehair sutures all around, usually with the graft overlapping the wound edge, and basted through

A B

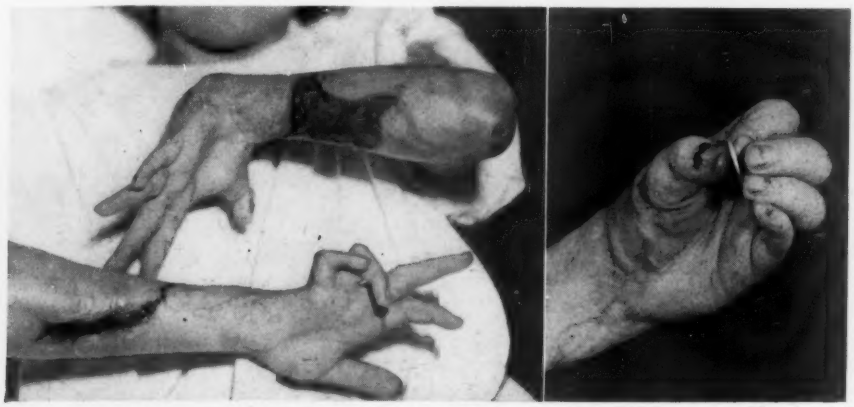

FIG. 3.—(A) Left hand completely out of position of function 18 months after a deep burn; with the arm still not healed. (B) Fairly normal position restored by three split-graft operations; with thumb and fingers functioning for the first time since the burn.

the center after multiple stab holes are made in the graft for drainage. (The general details of splinting and dressing are described later under full-thickness grafts.)

A

B C

FIG. 4.—(A) Widespread deep burns of the dorsum of both hands; corrected by careful dissection of the scar without damage to the tendons and covering each area with one large split-graft. (B) and (C) Shows complete permanent function three years later.

If ulcerated areas such as roentgen ray burns and the arm in Fig. 3 are grafted, the first dressing is the same except that the gauze next to the graft is wet with saline and is kept wet with irrigating tubes incorporated in the dressing, for four days. This plan of wet dressing is open to question, but,

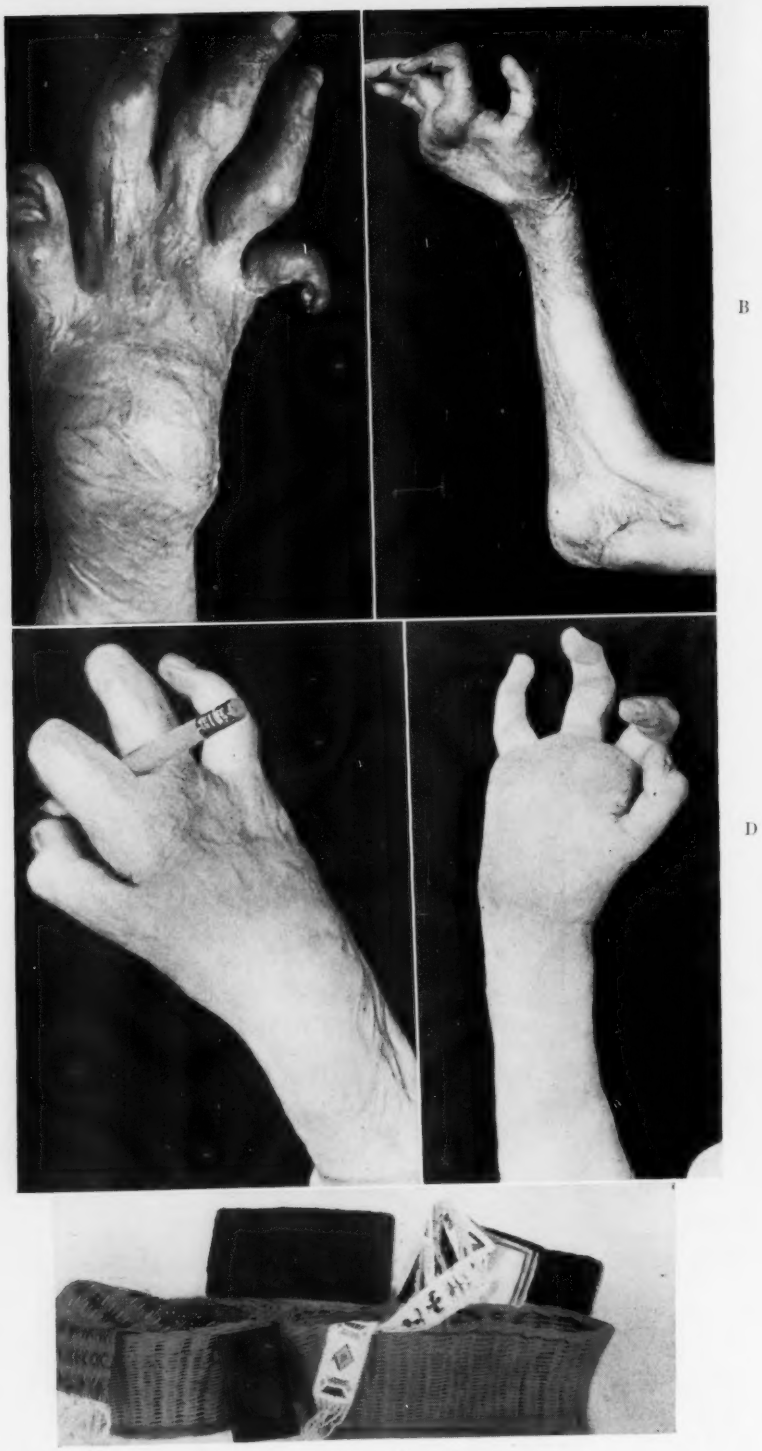

FIG. 5.—See legend on opposite page.

for the present, it seems to be the safest for the success of the graft, in most contaminated areas.

The split-graft is rough at first; the fine silk ligatures may work through to the surface, and have to be removed (Fig. 10 *D*); and many sebaceous collections may have to be emptied by pressure or small incisions. However, the grafts usually clear up so that in six to eight months they cannot be distinguished from a full-thickness graft or even normal skin in some instances (Fig. 2).

Partial Restoration of Function.—In some patients the deformities are so bad that complete function can never be expected. These result from excessive widespread surface loss, deep losses of tendons and dislocation of joints from primary or secondary contractures. Many of these deformities might be prevented by adopting the view that the lost skin should be replaced early; and there probably can never be any excuse for the completely webbed, or degloved hand as it has been called.

One of these patients is shown in Fig. 5 *A* and *B* who could not even dress himself. The thumb, fingers, and wrist were all out of position of function and the situation seemed almost hopeless, but in four operations the scars have gradually been removed, and the surface covered with thick split-grafts, so that the thumb is fairly well around and the wrist is up (Fig. 5, *C* and *D*). This result is not complete function, but the patient is able to get around normally and some of his work in occupational therapy is illustrated in Fig. 5 *E*. He is also able to draw and hopes to enter art school. His left hand was even worse than the right and was repaired in the same way.

Healed Deformities Repaired with Free Full-Thickness Grafts.—Dorsal surface loss can in many instances be successfully replaced with thick split-grafts (Fig. 4). Although there seems to be no actual measure of advantage of final function of the full-thickness graft, it is often relied upon, however, where widespread clean dissection and removal of the binding scar can be accomplished.

The patient in Fig. 6 *A* has complete loss of the use of the hand, with thumb and wrist entirely out of the position of function, and the fingers so held back that metacarpophalangeal dislocations and joint deformities will occur. This is the result of a widespread surface loss, but the depth of scar cannot be determined until the dissection of it has progressed. In this instance, complete function and movement were restored with a single free full-thickness graft from the abdomen put on at one operation, and covering the entire area (Fig. 6 *B*). At operation the scar is very carefully dissected from the underlying tendons; rough, forceful flexion of the wrist (or any other joint area

FIG. 5.—(A) and (B) Complete loss of use of hand one year after severe burns which have destroyed all the skin and many of the tendons and joints. Patient unable to dress himself. (C) and (D) After several operations of a rather slow progress in removing the scar skin and replacing it with split-grafts. Appearance not good, but patient able to draw well enough to enter art school and do work as shown in (E). (E) Part of many objects made as a result of instruction by occupational therapists.

that is being opened) will tear the scar overlying tendons and cause undesirable exposure of the tendons themselves. The scar is removed in layers if necessary, and, with cross-cuts in small areas to allow stretching, and the contracted tendons have to be gradually pulled out so that complete flexion can be obtained if possible. It is even advisable to leave a thin layer of scar on the tendons rather than expose them, if a free graft is to be used, because the graft will not grow on a large area of exposed tendons. When all relaxation

FIG. 6.—(A) Complete extension deformity following a widespread full-thickness loss of skin, with thumb and fingers definitely out of position of function. (B) Full restoration of function after careful dissection and coverage with a single full-thickness graft. Shown after two years to indicate the permanence of the result. There is complete flexion of the wrist and all carpal joints. (C) Method of fastening hand to wire (or solid aluminum splint) with sterile adhesive and of application of the graft (three hours operative time). (D) Three weeks after operation; full-take of graft; arm being taken off splint. (E) Abdominal defect healed by direct suture.

possible has been obtained, the hand is fastened to the wire mesh splint as illustrated, or to an aluminum splint prepared ahead of time, using sterile adhesive. The splint is bent to throw the wrist and fingers as far out of the former contracted position as possible and an accurate pattern of the defect is

cut. A full-thickness graft is then sutured all around the edges and up on the fingers (Fig. 6 *C*). The hand is shown in Fig. 6 *D* after three weeks' time with a full-take of the graft; it is now ready to be removed from the splint, and function can be started.

If the defect will not open completely at the first attempt because of tendons that are too tight or for fear of exposing too much of them on forced manipu-

FIG. 7.—(A) Complete flexion deformity and webbing of the fingers several years after a burn. (B) and (C) Full function obtained with one full-thickness graft and two subsequent procedures to relieve the webbing. (D) Hand shown at time of first dressing with molded marine sponge in place. Dorsal surface well padded. (E) Fine mesh, grease gauze next to the graft which is dry, indicating full-take of the graft. (F) Full-take shown with edge sutures; individual mattress sutures through the surface; stab-holes through the graft; and fingers held extended with silver wires through each tip and held to the wire splint.

lation, then whatever areas are open are grafted, and further freeing and grafting is done subsequently (Figs. 3 and 5). If tendons are lost and have to be replaced, or if they are too much exposed, then the advisability of using a thicker pedicle flap must be considered (Figs. 13 and 14).

Tunnel grafts have been reported as giving satisfactory results, especially

along the dorsal surfaces of the fingers, but they have not been employed in this group of patients.

Palmar surface losses can nearly always be repaired with free grafts. Deep losses along the fingers may require thicker flap repair, but full function in one of these is seldom obtained. The contracted single finger, especially in a child, that shows keloid formation, with its probable deep inflammation, may be one of the hardest deformities to repair, and careful consideration should always be given this apparently simple lesion.

The hand in Fig. 7 *A* has a complete flexion deformity and webbing of the fingers. Restoration was obtained with one full-thickness graft and two subsequent operations for the release of the webs (Fig. 7 *B* and *C*). The first dressing is shown in Fig. 7 *D*, *E* and *F*. The fingers have been held with silver transfixion wires around the terminal phalanges and fastened to the wire splint. The wire is used instead of tape when the graft comes so far out on the fingers. A pad of gauze separates the dorsal surface from the wire splint, and, over the knuckles, a thin rubber sponge may be used.

The question of late function of a free graft in the palm might well arise, and, in the answer, the anatomy may be considered. The skin and subcutaneous tissues of the palm are different than elsewhere; for normal function, the thenar pad is essential, the thumb must be as strong as the fingers and normal position and movements of the fingers are essential. When this area is resurfaced, the skin necessarily must come from another part of the body and it always retains its original characteristics and does not change into the type of skin of the sound palm. The grafts shown here in Figs. 7 to 10 have stood up under the patient's requirements, but, if any work proves to be too strenuous, there is little that can be done other than have the patient wear a glove for protection. In this instance, substituting a pedicle flap would seldom be of benefit because the difference of the skin surface would be the same as the free graft.

Details of the Full-Thickness Graft.—The 14 year old contracture, shown in Fig. 8 *A*, gave promise of a fairly good correction because there had been preservation of joint movement and tendon activity. The lengthening of these tendons by traction is not certain until the area is opened, but, for a successful correction in one operation, it is necessary that the entire deformity be opened and the hand maintained in complete correction during the period of healing of the graft. This point is almost as important when a pedicle flap is being employed and will be referred to later in Fig. 13.

Preparation of Bed for Graft.—Fig. 8 *B* shows the freeing obtained by removal of the small, transverse, heavy scars and then careful dissection backward of the palmar flaps without damage of the nerves or complete exposure of the tendons. The edges of the defect are not straight lines but have "darts" in them to allow maximum replacement of skin. If a straight, narrow graft is put in a child's finger, a possible keloid along the edge may produce deformity. The palmar flaps are utilized in making new interdigital spaces and for part of the finger coverage, and then patterns of the defects are cut in thin sheet

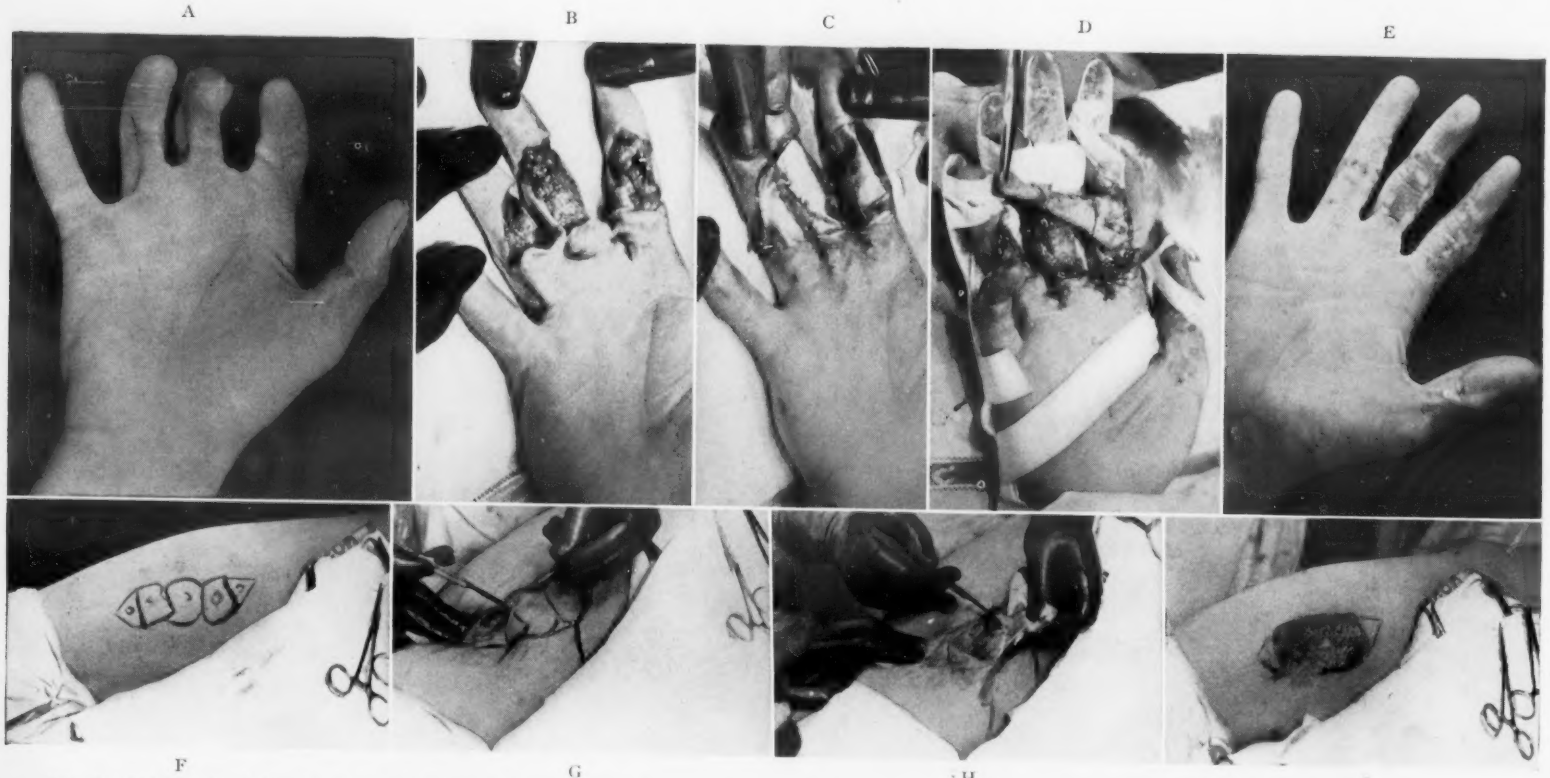

FIG. 8.—(A) Flexion deformity of 14 years' standing. (B) Careful opening without damage to nerves or tendons; careful hemostasis; fingers can be straightened. (C) The interdigital spaces have been made out of the contracted palmar skin. Lead patterns have been cut of all three defects. (D) The graft is sewed accurately all around the edges of the separate defects, and mattress sutures are put through the surface if necessary. (E) Result three months later. Patient satisfied with function, which is apparently normal. (F) The patterns have been traced and outlined through the skin of the inner part of the thigh. (G) and (H) The full-thickness of the skin is raised with as little damage as possible, using fine forceps and gauze for holding. No fat is taken up on the graft. (I) The graft is free and the resultant wound can be sutured or covered with a split-graft from an adjacent area.

lead (Fig. 8 *C*). Careful hemostasis is done with pressure and ligatures of white No. triple o silk.*

Cutting the Graft.—The patterns are outlined on the inner side of the thigh and an incision is made just through the skin (Fig. 8 *F*). Elevation of the full-thickness of the skin is then accomplished, using small forceps or gauze traction on the graft and some countertraction on the edges of the donor area to prevent any subcutaneous fat from adhering to the graft. Some small particles may persist which may be removed with scissors later—if these would retain their viability, they would be of great advantage (Fig. 8 *G* and *H*). The resultant defect of the donor area can now be closed directly or, if too large, can be covered rapidly with a split-skin graft from an adjacent area (Fig. 8 *I*).

Application of Graft.—The hand is fastened to a wire or aluminum splint with sterile adhesive, with the fingers extended, and can then be handled much more easily. The graft is sewed accurately into place all around the edges, in order to favor obtaining primary union; where edges are too loose to allow a normal stretch of the graft, reefing sutures may be taken to pull the edges back away from the defect. The tension with which the graft is sewed on—that is, from side-to-side—is best described as normal skin tension, *i.e.*, not pulled tightly like a drum-head, or left so loose that it may wrinkle (Fig. 8 *D*). If the graft is larger, then it is held down to the bed with additional mattress sutures through the surface (Fig. 7 *F*).

Dressing the Graft.—A few drainage holes are put through the graft and one layer of fine mesh, greased gauze (5 per cent scarlet red, xeroform or zinc oxide) is placed, very smoothly, next to the graft. Over this one or two gauze flats are placed and cotton or soft marine sponge is packed carefully between the fingers. Over this a soft, bleached, "wool-form" sea sponge is placed and bandaged firmly in place. A board splint is added for stability and the ends of the fingers are left visible. Fig. 7 *D*, *E* and *F* show a hand at the time of the first dressing, done eight days after operation. There is a full-take of the graft with no sign of infection, but dressings must be maintained for two weeks longer, using wet applications if inflammation should occur—otherwise continuing with the greased gauze. The sutures can be removed at the first or later dressings, and there may be an apparent delay in healing because so much of the surrounding, heavily keratinized skin comes away.

The splint is usually maintained for three weeks and then movements are gradually restored. This long fixation, which is primarily for the graft, helps the tendon lengthening also, but it does not do joint movement any good. If there is tendency for contraction after this period, the patient is usually allowed to go about his activities during the day, and at night the dorsal splint

* All possible skin is saved and utilized in making these repairs, and flaps may be shifted some distance, but the so-called Z-plastic, in which scar webs and bands are entirely depended on to obtain relaxation, and function has not been relied on in any patient in this series.

is reapplied, using either an aluminum one or a simple one made of wood and held on with adhesive.

Persistence of Function and Growth of a Free Skin Graft over a Nine-Year Period.—An important indication to the use of free grafts in general, in children, is illustrated by the patient shown in Fig. 9 *A*, who had a complete flexion deformity of the hand, of one year's duration. This was entirely corrected in one operation, with a single full-thickness graft covering the

FIG. 9.—(A) Complete flexion deformity of one year's duration. (B) and (C) Full function obtained by careful opening of the hand and covering with a full-thickness graft. Shown here one year later after removal of a slight webbing. (D) Shows same hand after nine years, with about same relative size, as compared with the other hand, having been preserved. Patient completely satisfied and not desirous of any further operative procedure.

palm and palmar surfaces of the fingers and thumb—three and one-half hours' operative time—(Fig. 9 *B* and *C*). The same hand is shown nine years later in Fig. 9 *D*, with full function being retained, and the boy satisfied and able to play baseball. The comparison in size with the right hand is about the same as when originally seen, the hand having about kept pace with the normal one, but not having picked up what was lost during the year of deformity. If there should be a lag in growth, dependent upon the graft, more skin could be put in at any time.

Roentgen Ray Burns.—In repairing roentgen ray burns wide excision and immediate grafting with thick split-skin grafts will give the most consistently

good results. If ulceration is present, or if there is bone or tendon exposed in the fingers, amputations may have to be performed, or a pocket-flap from the thigh or abdomen resorted to, but, with the promise of success by early

FIG. 10.—(A) and (C) Roentgen ray burns of entire palmar surfaces of both hands, with ulceration in the left that requires immediate removal. (B) and (D) Split-graft restorations in left hand after three years, in the right after three months. Normal function and sensation present in the left and anticipated in the right.

widespread free-skin grafting, most patients should fall short of this degree of neglect.

There have been so many failures with immediate free-grafting of roentgen ray burns that many surgeons prefer to excise the lesion first and then later graft a fresh granulating bed. There is, also, serious argument against im-

mediate grafting or application of flaps in any patient with a history of repeated infection or evidence of deep inflammation about the area. These areas should probably all be excised first, and repaired later, to avoid, as far as possible, serious crippling infection.

The patient in Fig. 10 *A* and *C* had widespread burns of both palms with ulceration in the left one. The first problem was to get rid of the changing area and repair it as well as possible. These areas are prepared with repeated soap and water cleansings and wet dressings for four days, and then widely and deeply excised without contamination of the deep area with the surface ulceration. The defect is covered with a single thick split-graft and a continuous wet pressure dressing maintained for four days. The area is then carefully nursed along until healed, and, in this patient, the final result is shown to be satisfactory with normal function persisting after three years (Fig. 10 *B*). The rest of the palmar skin will eventually have to be replaced, but at this time the entire palm of the opposite hand is removed and replaced with a single thick, split-graft in one operation (Fig. 10 *C* and *D*).

FIG. 11.—Complete restoration of tip of finger, including entire nail, eponychium and pad, by immediate resuture after it had been completely amputated and detached by a bread-cutting machine.

This procedure greatly simplifies matters for the patient, if successful, and eliminates the use of flaps in many instances. If the graft is lost, the patient is not far behind the two-stage procedure of later grafting, except that he has one more donor area to heal. In using split-grafts correctly this should practically never happen. The full-take of an immediate free full-thickness graft on a roentgen ray burn area is so questionable that they are seldom employed.

Complete Amputation of Finger Tips.—This subject is mentioned because of much conjecture regarding it, many misstatements of success and because one authentic success can be reported. The finger shown in Fig. 11 is the result of suture of the entire tip after it had been completely severed by a circular bread knife and had dropped down in the box. The loss was oblique from below the nail, and the amputated piece contained the entire nail and pad and possibly a very small piece of bone. The tip was put back on and about one hour later, the wound was inspected and the tip was again replaced, and this time accurately sutured. There was a complete take of the graft, with a rather slow course because of the heavy keratinized layer coming away, and, of course, the entire nail. There was, however, complete regeneration of the nail and its eponychium so that it appears normal. Dr. S. L. Koch saw the patient and suggested the possibility of grafting nails in this manner, but so far a patient with a good enough toe-nail to be placed on a finger has not been encountered. (Free-grafts of nails and part of their beds have not

been successful enough to report here.) It is thought that where there has been a clean amputation of a finger tip, immediate suture should be performed if possible. Crushing losses are not so likely to give good results, and immediate free-grafts can be utilized or a pad supplied later by a simple flap from the palm.

Web Fingers.—This lesion is mentioned because congenital cases never seem to have enough skin in the webs to give satisfactory covering of the sides of the fingers if normal flaps are put between the fingers. This interdigital flap is turned as a square U from the dorsal surface—as dorsal skin normally exists between the fingers—and is placed into an inverted T incision on the palmar surface. Then any flaps available are used on the sides, but there will practically always be defects that cannot be closed without

FIG. 12.—(A) and (B) Very wide flap torn by electric wringer with base distal. (C) Result of flap suture and loss, and subsequent closure of wound with small, deep grafts.

tension, and one premise of working with all defects in the hand is that they should be closed. Thick split-grafts are, therefore, sewed in place between the fingers and light sponge pressure dressings applied.

Two sides of one finger are never operated upon at the same time, so that in this patient two operations were necessary. This is the advice of Dr. Allen Kanavel, and the author has seen the loss of the ends of three fingers where this advice had not been followed.

Wringer and Other Laundry Machine Injuries.—Fairly frequent injuries are seen from catching the hand in electric wringers, and there is usually a large flap torn away with its base distal; there is seldom any tendon or bone damage, and, in a child, the tear may not occur until the arm has come between the rollers.

Many of these cases can be repaired by immediate resuture, and, if it is

possible to determine that viability of part of the flap is lost, this can be trimmed away and an immediate free-graft applied. The patient shown in

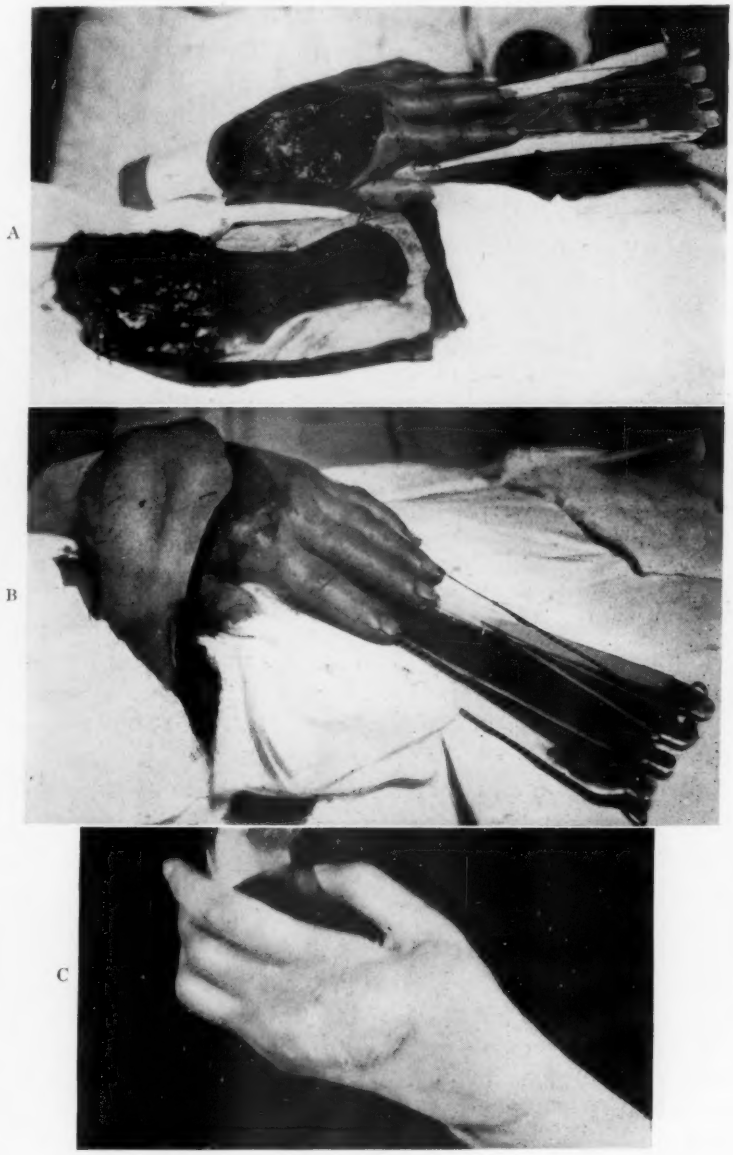

FIG. 13.—(A) and (B) Shotgun wound of hand with repair by a direct pedicle flap from the abdomen. Hand splinted to give traction for the fingers, and thumb rotated. Same splint used after hand is detached to obtain joint motion and maintain traction. A small wound of entry on the palmar surface was left to close itself. (C) Result is a hand that is far superior to any prosthesis that might be devised.

Fig. 12 had a very large flap torn loose, and, because of poor physical condition, a chance was taken in replacing all of it. There was loss around the

wrist, and healing has been hurried with small deep grafts applied without anesthesia.

Other laundry injuries are shown in Figs. 1 and 2. Some have tendon, joint or bone damage, so that pedicle-flap repairs become necessary.

Pedicle-Flap Repairs of the Hand.—There are definite indications for the use of thick pedicle flaps in hand repairs, such as: Deep roentgen ray burns of the dorsum; gunshot wounds; any deep wound that exposes too much tendon, bone or joint; or any late repair that will subsequently need work on tendon or bone and which could not be accomplished with just a free-graft restoration of the surface. A broad or double pedicle can nearly always be arranged so that the flap does not have to be delayed.

Probably as many pitfalls occur in the use of flaps as in free-grafts, and patients are frequently seen with inadequate flaps, bunched up in a pad on the hand, only replacing part of the deformity.

One of the necessary uses of a flap is illustrated in Fig. 13 *A*. The hand was placed right over a shotgun muzzle, and a small wound of entry was present on the palm, but with the huge excavation shown on the dorsum. Amputation had been considered, but it was suggested that at least an attempt might be made to save the hand. Accordingly, after eight days of cleaning the area, a direct flap from the right lower quadrant was sewed in place. Important points, shown in Fig. 13 *A* and *B*, are that the hand is on a splint from the start—even carrying it across the abdomen. The fingers are held extended by simple rubber traction from holes in the finger nails to simple notches on the end of the splint. This same traction was maintained during the entire period of attachment of four weeks; otherwise, there would have been retraction of the fingers the distance of the loss of the metacarpals, and also marked bunching up of the flap. Another important point is that a cut-out has been made on the splint to allow rotation of the thumb. This splint can be employed after operation to gain freedom of the joints, by simply bending the splint with the hand on it. The result (Fig. 13 *C*) is a hand that is useful in all housework, far superior to any artificial one, and superior to any possible result that could have been obtained with a free skin graft.

The patient shown in Fig. 14 *A* had a contraction of the hand and wrist from an infection that had bound the tendons so tightly that there was no movement. At operation a wide dissection of the scar was effected, and the wrist let down, with so much exposure of deep structures that a direct abdominal flap from the opposite lower quadrant was put in place. The abdominal wall itself is used as a splint in this instance with the wrist and hand flexed around it as comfortably as possible (Fig. 14 *D*). The final result with the wrist flexed is shown in Fig. 14 *B* and *C*, but without much flexion in the metacarpophalangeal joints. The remaining wide, raw area over the abdomen is covered with split-grafts, as this seems better than drawing the area together or letting it heal itself.

Occupational and Physical Therapy.—Following surface repairs in which there has been no deep involvement, if a good result can be obtained and the

patient is fairly interested in his recovery, very little else need be done about his rehabilitation. Children usually work out their own problems but, if much joint stiffness has developed, considerable difficulty may be experienced in getting it out of the metacarpophalangeal joints, and especially in women who are not likely to need this joint completely flexed. Simple work in the home with the early use of rubber sponge exercise in closing the hand, and

FIG. 14.—(A) Extension deformity of fingers and wrist following a wide skin loss and tendon damage from infection. (B) and (C) Voluntary flexion of wrist, but not much flexion of metacarpophalangeal joints obtained. However, the hand, in general, almost normal in function. (D) Hand splinted across abdomen, with flexion maintained and direct abdominal flap growing in place.

such grosser movements as sweeping, shoveling, *etc.*, may quickly loosen the joints. Manipulation to swing thumbs around into place may be done frequently, but forced manipulation of these joints rarely produces anything but more stiffness. Elastic traction and rotation of the thumb as illustrated in Fig. 13, and as advocated by Kanavel, Koch and Mason for rehabilitation in deeper repairs, will produce the quickest freeing of joint fixation. The finer movements of the interossei and lumbricals can be greatly stimulated by occu-

pational therapy, and many excellent results may be obtained. Secondary operative procedures on the metacarpophalangeal joints may occasionally be of benefit and very badly dislocated phalangeal joints may be resected or an attempt at arthroplasty instituted, but the indications for this last procedure are very infrequent.

Discussion.—Dr. J. M. T. Finney, Sr. (Baltimore, Md.).—In substantiation of what Doctor Brown has said about severed members and their replacement, I should like to report a personal experience. Many years ago a young man came to the Johns Hopkins Hospital Dispensary with the ends of two fingers—the ring and middle fingers—cut squarely off by a chopping machine. He was a tin cutter by trade. The middle finger had been severed just below the last joint, leaving a small disk of the terminal phalanx; the ring finger, just at the base of the nail. He said the accident had occurred over five hours previously.

The cut surfaces looked clean; the bleeding had stopped. I asked what had become of the severed ends of the fingers. He put his hand in his pocket and pulled out a piece of newspaper, from which he produced the missing finger ends. They looked clean, so I soaked them and the stumps of the fingers for at least an hour in warm salt solution. I then took a sharp knife and carefully scraped both cut surfaces of each finger, and carefully replaced them. One stitch of fine silk was taken in each of the four cardinal points. I then held the fragments in close and accurate apposition by narrow strips of crepe tissue over the end, extending up the finger on both sides, held in place by collodion, which splinted the fragments perfectly. The fingers were then put up together on a splint. Perfect healing per primam was obtained, without any infection, in each finger. I followed the patient for some years afterwards, at the end of which time use and sensation were perfect.

I want to congratulate Doctor Brown on his excellent paper and his splendid results. The history of the development of plastic surgery is a most interesting one. The results to-day, compared with those of 50 years ago, are extraordinarily satisfactory.

Dr. Ellis Fischel (St. Louis, Mo.) did not think that one should lose sight of the fact that many years of patient trial and error were involved in the evolution of the meticulous technic recited by Doctor Brown. He also felt that very few would have the patience to undertake the essential details, not only of the operation but also of the dressings, that were necessary. However, there are some simple things a general surgeon can do to repair defects in the hands which he himself creates. In carcinoma of the back of the hand, which does not involve the tendon sheaths, and which occurs usually in elderly people, it is not necessary to employ irradiation by either roentgen ray or radium. It is easy to excise a lesion the size of a silver dollar, or even larger, under infiltration anesthesia, and immediately repair the defect by a skin graft. Healing occurs in about ten days' time.

A similar but more difficult procedure can be employed to repair the defect caused by excision of a carcinoma arising in old roentgen ray burns. In these cases not only the tumor but all the neighboring scar tissue should be excised, and the resultant soft tissue defect should be repaired immediately by the method so ably illustrated by Doctor Brown; namely, by suturing a split- or full-thickness graft into the defect. A careful pressure dressing is essential to the success of this procedure, which gives eminently satisfactory results with a minimum of time for after-care.

Dr. John Staige Davis (Baltimore, Md.) said he would like to congratulate Doctor Brown on the splendid work he had shown today. He had been interested in whole-thickness skin grafting for a long time; in fact, the first paper he ever wrote was on the relief of scar contractures by the use of whole-thickness grafts. These grafts should be employed more than they are; but unless one is familiar with the technic and has had experience in handling these grafts, he will not get as good results as have been shown in this very unusual presentation of Doctor Brown's.

THE INFLUENCE OF PREOPERATIVE MEDICATION ON POSTOPERATIVE COMPLICATIONS

A STATISTICAL STUDY

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THIS paper is based upon a review of the records of 9,592 operations that were performed at St. Luke's Hospital, between the years 1921 and 1936. All of the cases that are included in this review received some derivative of opium combined with either atropine, hyoscine, or one of the barbiturates preoperatively. Since dilauded, pantapon and codeine were used in less than 100 cases, they have been considered together under the general heading of morphine. There were 6,591 cases that received morphine and atropine, 2,613 that received morphine and hyoscine, and 388 that received morphine and one of the barbiturates. Tabulations have been prepared which show the complications which occurred after each type of preoperative medication.

All of the usual postoperative complications were recorded, but only two stood out conspicuously; namely, catheterization, and the subsequent development of cystitis and pyelitis as manifested by pus in the urine. On account of this finding, no genito-urinary cases were included in this study. No definite relationship was found between the anesthetic and the number or type of the complication.

TABLE I

492 CASES OF THYROIDECTOMY

(*Mortality-Rate 3.2 per cent*)

	Morphine-Atropine	Morphine-Hyoscine	Morphine-Barbital
No. of cases	275	140	77
No. catheterized	6	4	1
Percentage catheterized	2.2%	2.8%	1.3%
Cystitis-pyelitis	0	1	0
Percentage cystitis-pyelitis	0	0.7%	0
Pneumonia	6	5	2
Acute crises	8	5	1
Deaths	7	7	2
Total complications	20	14	2
Percentage of complications	7.2%	10 %	5.2%

Table I shows an analysis of 492 thyroidectomies. Of these 275 received morphine-atropine preoperatively, 140 morphine-hyoscine, and 77 morphine-

barbital. In the morphine-atropine group, 2.2 per cent were catheterized; in the morphine-hyoscine group, 2.8 per cent, and in the morphine-barbital group, 1.3 per cent. In the morphine-atropine group, 7.2 per cent of the patients developed some form of complication, 10 per cent in the morphine-hyoscine group and 5.2 per cent in the morphine-barbital group.

TABLE II

410 CASES OF BREAST AMPUTATION

(*Mortality-Rate 1.5 per cent*)

	Morphine-Atropine	Morphine-Hyoscine	Morphine-Barbital
No. of cases	328	58	24
No. catheterized	15	7	2
Percentage catheterized	4.6%	12.2%	8.3%
Cystitis-pyelitis	3	2	0
Percentage cystitis-pyelitis	0.9%	3.4%	0
Pulmonary infarct	2	0	0
Shock-hemorrhage	1	0	0
Pneumonia	1	0	0
General carcinoma	3	1	0
Deaths	5	1	0
Total complications	22	8	2
Percentage of complications	6.7%	13.8%	8.3%

Table II shows an analysis of 410 breast amputations: 328 received morphine-atropine preoperatively, 58 morphine-hyoscine, and 24 morphine-barbital. Four point six per cent were catheterized in the morphine-atropine group; 12.2 per cent in the morphine-hyoscine group; and 8.3 per cent in the morphine-barbital group. There were 0.9 per cent in the morphine-atropine group that developed cystitis or pyelitis; 3.4 per cent in the morphine-hyoscine group, and none in the morphine-barbital group. In the morphine-atropine group, 6.7 per cent developed some form of complication; 13.8 per cent in the morphine-hyoscine group, and 8.3 per cent in the morphine-barbital group.

Table III shows an analysis of 789 herniotomies: 664 received morphine-atropine, 97 morphine-hyoscine, and 28 morphine-barbital. Ten point eight per cent were catheterized in the morphine-atropine group; 21.6 per cent in the morphine-hyoscine group; and 3.6 per cent in the morphine-barbital group. There were 1.2 per cent in the morphine-atropine group that developed cystitis or pyelitis; 5.2 per cent in the morphine-hyoscine group; and none in the morphine-barbital group. In the morphine-atropine group, 13 per cent developed some form of complication; 29.9 per cent in the morphine-hyoscine group; and 10.7 per cent in the morphine-barbital group.

TABLE III

789 OPERATIONS UPON HERNIAE

(*Mortality-Rate 1.5 per cent*)

	Morphine-Atropine	Morphine-Hyoscine	Morphine-Barbital
No. of cases	664	97	28
No. catheterized	72	21	1
Percentage catheterized	10.8%	21.6%	3.6%
Cystitis-pyelitis	8	5	0
Percentage cystitis-pyelitis	1.2%	5.2%	0
Pneumonia	8	2	1
Bronchitis	0	2	0
Pleurisy	3	2	0
Peritonitis	2	0	0
Pulmonary embolus	5	1	0
P. O. hemorrhage	2	0	0
Intestinal obstruction	0	1	0
Myocarditis	1	0	0
Deaths	10	2	1
Total complications	93	29	3
Percentage of complications	13 %	29.9%	10.7%

TABLE IV

4,173 CASES OF APPENDICECTOMY

(*Mortality-Rate 1.9 per cent*)

	Morphine-Atropine	Morphine-Hyoscine	Morphine-Barbital
No. of cases	3,057	1,036	100
No. catheterized	452	299	15
Percentage catheterized	14.7%	22.1%	15%
Cystitis-pyelitis	53	56	2
Percentage cystitis-pyelitis	1.7%	5.4%	2%
Peritonitis	39	10	0
Pulmonary embolus	11	6	0
Pneumonia	18	11	1
P. O. hemorrhage	4	0	0
Pleurisy	0	8	0
Phlebitis	20	8	0
Bronchitis	0	6	1
P. O. shock	2	0	0
Intestinal obstruction	3	2	0
Typhoid fever	1	1	0
Deaths	59	20	1
Total complications	566	279	18
Percentage of complications	18.7%	27 %	18%

Table IV shows an analysis of 4,173 appendicectomies: 3,057 received morphine-atropine, 1,036 morphine-hyoscine, and 100 morphine-barbital. Fourteen point seven per cent were catheterized in the morphine-atropine group; 22.1 per cent in the morphine-hyoscine group; and 15 per cent in the morphine-barbital group. There were 1.7 per cent in the morphine-atropine group that developed cystitis or pyelitis; 5.4 per cent in the morphine-hyoscine group; and 2 per cent in the morphine-barbital group. In the morphine-atropine group, 18.7 per cent developed some form of complication; 27 per cent in the morphine-hyoscine group; and 18 per cent in the morphine-barbital group.

TABLE V

1,083 OPERATIONS UPON THE GALLBLADDER

(*Mortality-Rate 5.7 per cent*)

	Morphine-Atropine	Morphine-Hyoscine	Morphine-Barbital
No. of cases	796	243	44
No. catheterized	132	53	5
Percentage catheterized	16.6%	21.8%	11.4%
Cystitis-pyelitis	21	16	0
Percentage cystitis-pyelitis	2.6%	6.6%	0
Peritonitis	9	3	0
P. O. hemorrhage	14	7	0
Pneumonia	24	5	0
Bronchitis	0	3	0
Pleurisy	2	1	0
Pulmonary embolus	5	1	1
Phlebitis	3	3	0
Liver shock	2	0	0
Myocarditis	5	0	0
Intestinal obstruction	4	0	0
Deaths	48	13	1
Total complications	195	76	6
Percentage of complications	24.5%	31.3%	13.6%

Table V shows an analysis of 1,083 gallbladder operations: 796 received morphine-atropine, 243 morphine-hyoscine, and 44 morphine-barbital. Sixteen point six per cent were catheterized in the morphine-atropine group; 21.8 per cent in the morphine-hyoscine group; and 11.4 per cent in the morphine-barbital group. There were 2.6 per cent in the morphine-atropine group that developed cystitis or pyelitis; 6.6 per cent in the morphine-hyoscine group; and none in the morphine-barbital group. In the morphine-atropine group, 24.5 per cent developed some form of complication; 31.3 per cent in the morphine-hyoscine group; and 13.6 per cent in the morphine-barbital group.

Table VI shows an analysis of 666 gastro-intestinal operations: stomach, small intestines and colon. Four hundred eighty-eight received morphine-atropine, 140 morphine-hyoscine, and 38 morphine-barbital. Twelve point

five per cent were catheterized in the morphine-atropine group; 26.4 per cent in the morphine-hyoscine group; and 10.3 per cent in the morphine-barbital group. There were 4 per cent in the morphine-atropine group that developed cystitis or pyelitis; 4.3 per cent in the morphine-hyoscine group; and none in the morphine-barbital group. In the morphine-atropine group, 25.5 per cent developed some form of complication; 37.8 per cent in the morphine-hyoscine group; and 21 per cent in the morphine-barbital group.

TABLE VI

666 OPERATIONS UPON THE GASTRO-INTESTINAL TRACT

(*Mortality-Rate 18.7 per cent*)

	Morphine-Atropine	Morphine-Hyoscine	Morphine-Barbital
No. of cases	488	140	38
No. catheterized	61	37	4
Percentage catheterized	12.5%	26.4%	10.3%
Cystitis-pyelitis	20	6	0
Percentage cystitis-pyelitis	4 %	4.3%	0
Pulmonary embolus	5	0	0
Pneumonia	21	8	1
Bronchitis	4	0	1
Pleurisy	1	0	0
Peritonitis	17	3	1
Intestinal obstruction	8	3	0
P. O. shock	6	0	0
Phlebitis	1	0	1
Cardiac failure	0	2	0
General carcinoma	45	16	3
Deaths	92	29	4
Total complications	124	52	8
Percentage of complications	25.5%	37.8%	21 %

Table VII shows an analysis of 963 operations upon the uterus and the adnexa. Five hundred fifty-nine received morphine-atropine, 372 morphine-hyoscine, and 32 morphine-barbital. Twenty-one point eight per cent were catheterized in the morphine-atropine group; 54 per cent in the morphine-hyoscine group; and 13.6 per cent in the morphine-barbital group. There were 3.4 per cent in the morphine-atropine group that developed cystitis or pyelitis; 17.2 per cent in the morphine-hyoscine group; and 3.1 per cent in the morphine-barbital group. In the morphine-atropine group, 25.5 per cent developed some form of complication; 58.3 per cent in the morphine-hyoscine group; and 15.6 per cent in the morphine-barbital group.

Table VIII shows an analysis of 1,016 abdominal hysterectomies. Four hundred forty-four received morphine-atropine, 527 morphine-hyoscine, and 45 morphine-barbital. Thirty point six per cent were catheterized in the morphine-atropine group; 57.2 per cent in the morphine-hyoscine group; and 20 per cent in the morphine-barbital group. There were 6.8 per cent in the morphine-atropine group that developed cystitis or pyelitis; 33.6 per cent

in the morphine-hyoscine group; and 4 per cent in the morphine-barbital group. In the morphine-atropine group, 37 per cent developed some form of complication; 62.4 per cent in the morphine-hyoscine group; and 22.2 per cent in the morphine-barbital group.

TABLE VII

963 OPERATIONS UPON THE UTERUS AND ADNEXA

(*Mortality-Rate 1.9 per cent*)

	Morphine-Atropine	Morphine-Hyoscine	Morphine-Barbital
No. of cases	559	372	32
No. catheterized	122	201	5
Percentage catheterized	21.8%	54 %	13.6%
Cystitis-pyelitis	19	64	1
Percentage cystitis-pyelitis	3.4%	17.2%	3.1%
Pulmonary embolus	1	2	0
Pneumonia	2	4	0
P. O. hemorrhage	3	1	0
Peritonitis	6	1	0
Pyelonephritis	1	0	0
Phlebitis	6	3	0
P. O. shock	3	0	0
Intestinal obstruction	0	2	0
Deaths	13	6	0
Total complications	143	217	5
Percentage of complications	25.5%	58.3%	15.6%

TABLE VIII

1,016 OPERATIONS FOR HYSTERECTOMY

(*Mortality-Rate 3 per cent*)

	Morphine-Atropine	Morphine-Hyoscine	Morphine-Barbital
No. of cases	444	527	45
No. catheterized	136	302	9
Percentage catheterized	30.6%	57.2%	20 %
Cystitis-pyelitis	30	177	2
Percentage cystitis-pyelitis	6.8%	33.6%	4 %
Peritonitis	3	5	0
Phlebitis	7	7	0
Pulmonary embolus	3	2	0
Pneumonia	12	12	1
P. O. hemorrhage	4	1	0
Deaths	15	15	1
Total complications	165	329	10
Percentage of complications	37 %	62.4%	22.2%

It is interesting to note that the percentage of catheterization was unusually high in pelvic operations, which is in all probability due to the close proximity of the bladder to the operative field.

TABLE IX

RÉSUMÉ SHOWING THE PERCENTAGE OF COMPLICATIONS FOR EACH GROUP OF OPERATIONS

Operation	Morphine-Atropine	Morphine-Hyoscine	Morphine-Barbital
Thyroid	7.2%	10 %	5.2%
Breast	6.7%	13.8%	8.3%
Hernia	13 %	29.8%	10.7%
Appendicectomy	18.7%	27 %	18 %
Gallbladder	24.5%	31.3%	13.6%
Gastro-Intestinal	25.5%	37.8%	21 %
Pelvic Adnexa	25.5%	58.3%	15.6%
Hysterectomy	37 %	62.4%	22.2%

Table IX shows a comparison of the total number of complications that occurred after each type of operation, in the morphine-atropine, morphine-hyoscine and morphine-barbital groups. It will be noted that where morphine-hyoscine was used preoperatively the percentage of complications is higher for all operations than where morphine-atropine or morphine-barbital was used.

TABLE X

RÉSUMÉ SHOWING THE PERCENTAGE OF OCCURRENCE OF CYSTITIS OR PYELITIS AS A COMPLICATION IN 7,901 ABDOMINAL OPERATIONS

	Morphine-Atropine	Morphine-Hyoscine	Morphine-Barbital
Abdominal operations	5,324	2,318	259
No. catheterized	903	822	42
Percentage catheterized	16.9%	25.4%	16.2%
No. cystitis-pyelitis	143	319	6
Percentage cystitis-pyelitis	2.7%	13.7%	2.3%
Percentage of those catheterized that developed cystitis or pyelitis	15.8%	38.8%	14.3%

Table X shows a résumé of the 7,901 abdominal operations. Five thousand, three hundred twenty-four received morphine-atropine preoperatively, 2,318 morphine-hyoscine, and 259 morphine-barbital. Sixteen point nine per cent were catheterized in the morphine-atropine group; 25.4 per cent in the morphine-hyoscine group; and 16.2 per cent in the morphine-barbital group. In the morphine-atropine group, 2.7 per cent developed cystitis or pyelitis; 13.7 per cent in the morphine-hyoscine group; and 2.3 per cent in the morphine-barbital group. Of the 903 patients that were catheterized, in the morphine-atropine group 15.8 per cent developed cystitis or pyelitis; 38.8 per cent in the morphine-hyoscine group; and 14.3 per cent in the morphine-barbital group.

The higher percentage that developed cystitis or pyelitis in the morphine-

hyoscine group is in all probability due to the fact that each individual patient needing catheterization, was catheterized more often than the patients in the other groups, since the narcosis was more prolonged.

CONCLUSIONS

1. From this study, one is justified in concluding that preoperative medication definitely influences the postoperative complications.

2. When morphine and hyoscine are used preoperatively, the percentage of postoperative complications is higher than when morphine is combined with atropine or one of the barbiturates.

3. The combination of morphine and one of the barbiturates, apparently shows the least number of postoperative complications, but the group reviewed is too small from which to draw any conclusions.

DISCUSSION.—DR. JOHN W. PRICE (Louisville, Ky.).—This subject that Doctor Mastin has brought up is, I think, very timely. It is one that has interested me for a great many years, and especially the use of morphine both as a preoperative and postoperative medication. At one time I saw two striking examples of ill health following the use of morphine by a reputable physician. One of these cases was a very beautiful girl who had been made an addict by one of the safest practitioners of my acquaintance. Another was an elderly lady whose physician was thoughtless, and she had become an addict. So I decided that I would experiment with the least amount of morphine that I could do with for my cases, both preoperative and postoperative, and we started out giving no morphine preoperatively; and then we told the house staff that only those cases which seemed definitely uncomfortable postoperatively, should be given morphine. We carried that out on a series of only 200. That is not a large number, but we did find in the end that we had given only an average of one-eighth grain of morphine per patient, which meant that many had no morphine either before or after operation.

Doctor Mastin's statistics show the complications following the use of morphine and hyoscine and, as I understand it, they are all taken from one hospital, where catheterization is performed by the same staff of nurses, orderlies or interns, and that there is a great difference between the complications following catheterization on the cases that have had hyoscine, morphine, barbital, and atropine. One would think the technic of catheterization was the same throughout, and one wonders why the percentage of pyelitis following catheterization should vary, unless the cases that had morphine and hyoscine had to be catheterized much more frequently than the cases that did not.

DR. LUCIUS E. BURCH (Nashville, Tenn.).—I should like to ask the speaker whether he has statistics on complications following general anesthesia and those following local. I also have one suggestion to make in avoiding complications, especially pyelitis and cystitis, and that is, if the case is not an emergency one, to teach the patient for a day or two before operation to use the bed pan and urinal.

DR. E. V. MASTIN (closing).—In answer to Doctor Burch's question, I was unable to notice that the anesthetic played any part in the number or type of complications. In the review of the first 1,000 cases I checked the complications following each individual anesthetic, and I did not notice that the percentage was varied enough to carry it out for the entire group.

INTERNAL FIXATION OF FRACTURES OF THE NECK OF THE FEMUR

AN ANALYSIS OF RESULTS

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CINCINNATI, OHIO

WE BELIEVE that enough successful cases of internal fixation of fractures of the neck of the femur have been reported to make most of us at least conscious of the fact that it is a good method of treatment. One test for any particular form of therapy is its applicability. We have not only made internal fixation our method of choice but have been able to employ it in almost all of our cases. During the last three years all of our intracapsular fractures, with two exceptions, have been so treated, and if we had to do those two over again, we believe, in the light of our increased experience, that we would use this method now. At first, we did not use pins at all in cases of intertrochanteric fractures, and a good many patients were treated by other methods. In the last two years, however, we have consistently used internal fixation, except when the outer fragment has been so comminuted that it was felt that it would not be strong enough to hold the pins. We wish to discuss a few of the difficulties which have been encountered, and to describe the technic which has been developed.

In the first place, it must be stated that we selected the Austin Moore method of treatment as being, in our minds, superior to either the Smith-Peterson nail or Kirschner wires. We felt at that time (1935, before blind nailing or wire guides had been developed) that the Smith-Peterson operation was too severe and too hazardous for the vast majority of cases and that the wires were too inadequate. We, therefore, prepared ourselves to apply the Austin Moore method of treatment to our cases and tried our best to follow his technic as he had originally published it. We learned, however, that a great many details had not been covered in his original communication and we had to develop our own methods to deal with these contingencies.

In the beginning we were unable to judge the length of the pin to be inserted, or rather we were unable to judge the dimensions of the bones as they appeared in the roentgenogram. As a consequence our first pins went in too deeply and crossed into the acetabulum. This, of course, was not desirable, and in order to avoid it, there was a tendency to put our pins in not quite deep enough. It was discovered that the pins must go into the cortical structure of the head. If the pointed ends of the pins stop in the cancellous structure of the bone they will not hold well, even though they have crossed the line of fracture. We believe, therefore, that it is quite important to get them in quite deeply but not too deep.

It has been the problem of properly directing the pins, however, which

has caused us the greatest concern. We have now developed a technic which we believe to be quite satisfactory and which can be easily employed. All of our cases are operated upon the Hawley table. Before putting the patient on the table we substitute in place of the pelvic rest a tunnel through which roentgenologic casettes can be shifted. As soon as the area is anesthetized either with local, spinal or general anesthetic, as one desires, the fracture is reduced, and the feet tied to the foot pieces of the Hawley table, the legs

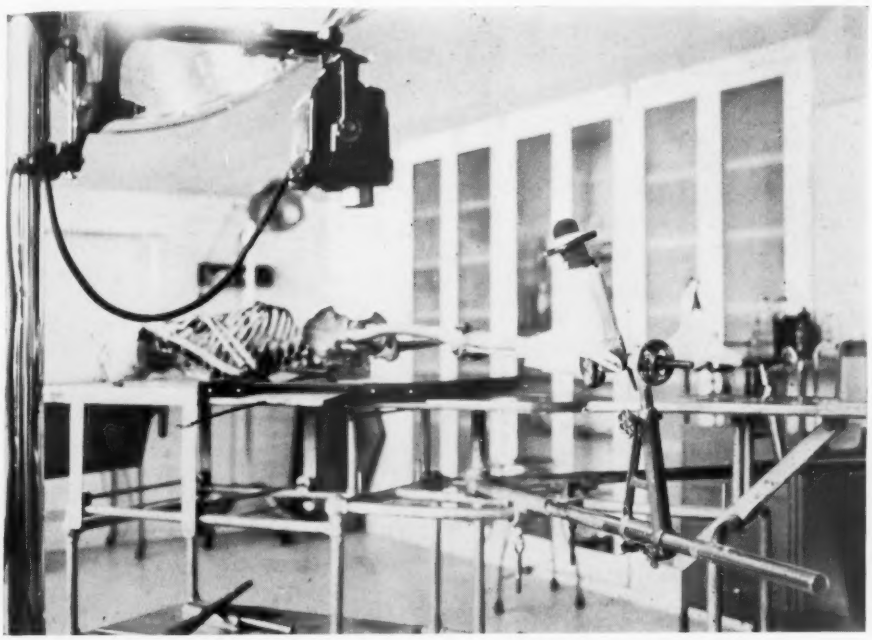

FIG. 1.—Method of Getting an Anteroposterior View of the Fracture: The fracture has been reduced and the feet have been tied to the foot pieces, so that the position of the fragments remains constant throughout the operation.

being placed in a fair degree of abduction. Following this the middle of Poupart's ligament is marked with gentian violet, and at the same time a clip is placed in the skin at this point. Two roentgenograms are then made, one in the anteroposterior, and the other in the lateral direction, for which latter purpose we use a curved casette placed between the thighs. We do not shift the leg for the purpose of obtaining a lateral view, in fact, we do not move the leg at all until the operation is over. While these pictures are being developed, the operator can finish scrubbing up, and the patient can be painted and draped. Examination of the roentgenograms then determines whether or not the reduction is good (if poor, the fracture is reduced again), and one is also able to determine the exact angle of the neck in relationship to horizontal. In other words, the curved casette upon which the lateral picture has been made has been placed firmly upon the Hawley table, and, therefore, the lower edge of the film is parallel to the Hawley table and consequently horizontal.

The neck of the bone is clearly outlined upon this film and its angle with the horizontal is easily seen. In order to transfer this angle to the operator,

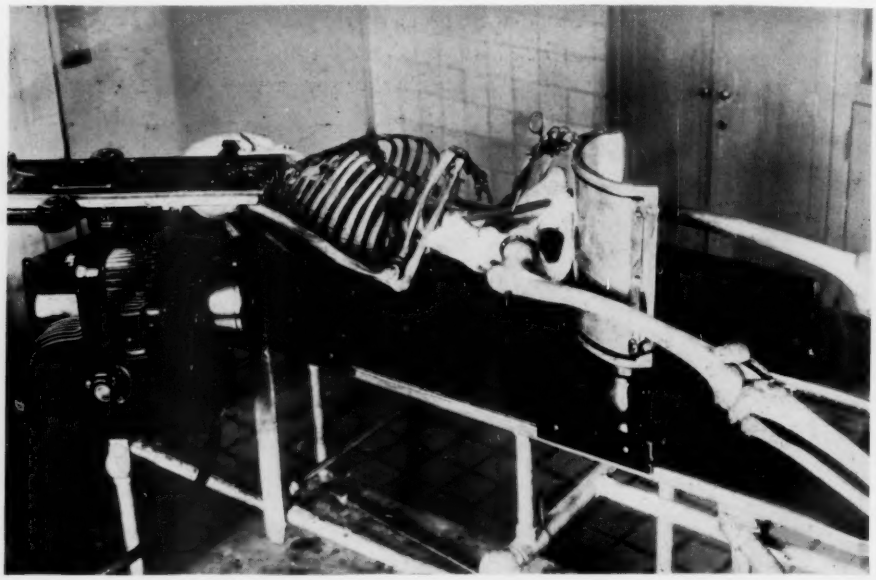

FIG. 2.—Method of Getting a Lateral View of the Fracture: The curved casette is placed upon the table firmly, which causes the lower edge of the film to be horizontal. The lateral angle of the neck as it appears at that moment, with the feet tied as they are, is easily seen on the resulting film. Note hemostat clamped to Poupart's ligament at its middle is directly over center of acetabulum.

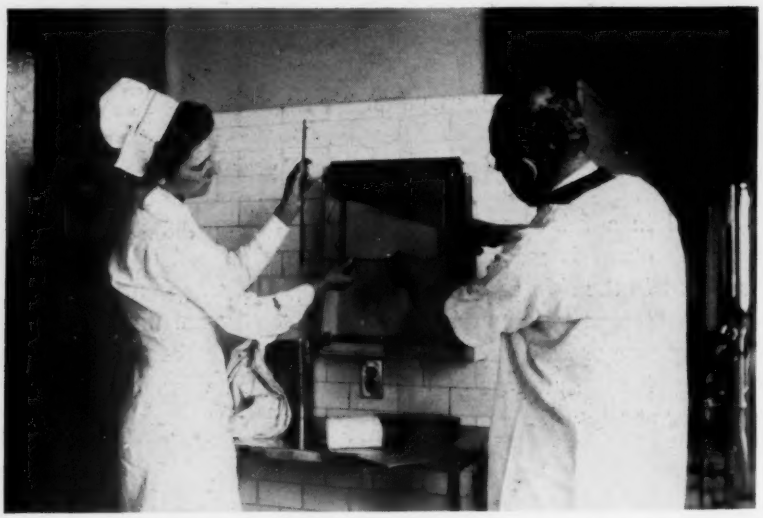

FIG. 3.—With one edge of the card held parallel to the lower edge of the film, the other edge of the card can be cut to show the angle of the neck.

the roentgenologist can quickly and easily cut a card in such a fashion that one edge is parallel with the lower edge of the film, and the other edge is parallel to the center line of the neck, as viewed in the lateral position. When

the operator is about to insert his pins, someone can stand at the head of the table with his eyes at the level of the incision and holding this card with

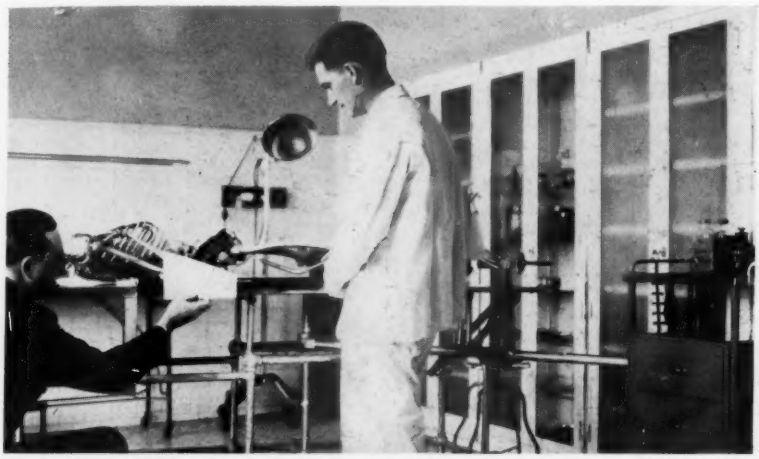

FIG. 4.—This card is held by an assistant who can line up the pin in the proper direction with his eye.

one edge horizontal, can tell the surgeon whether to thrust his pin up or down or level, as the case may be. He does this by paralleling the direction

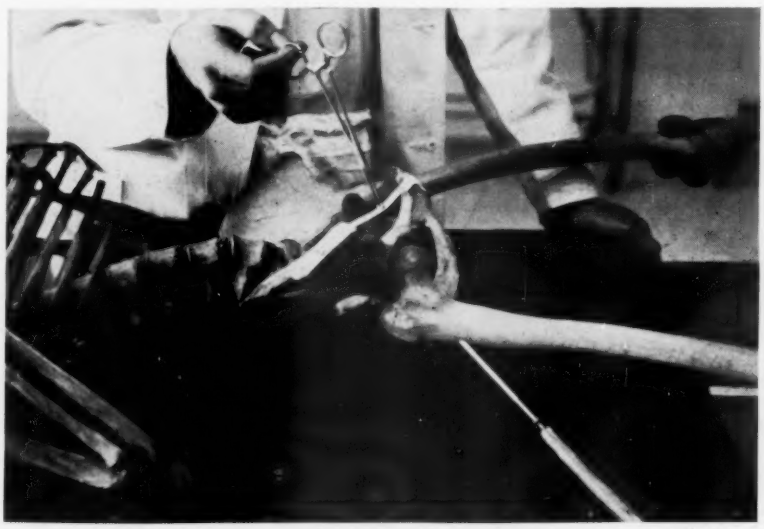

FIG. 5.—An Allis forceps has been placed at the middle of Poupart's ligament. Looking at the the patient from above, it will be seen that it is situated directly over the center of the acetabulum, and that a pin directed toward this point will go into the head.

of the pin with the line at the edge of the card. The operator himself can aim for the head of the bone in the anteroposterior view by aiming for the skin clip which has been previously placed. The anteroposterior roentgenogram will show whether this clip is a little too high, too low, or in the right

place, and one can judge any slight change in direction which might have to be made.

With these preparations, and the cooperation of a reliable roentgenologist, the operation is simple. As soon as the preliminary roentgenograms show a

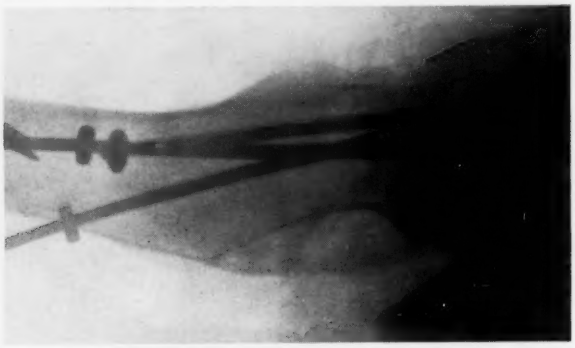

FIG. 6.—Lateral view. This shows the pins introduced. Lateral view of the neck of the femur showing pins running down the neck into the head. It also shows the angle of the neck to the horizontal.

good reduction and a proper angle of the neck, a four inch incision is made and the muscle split down to bone. No attempt is made to raise the periosteum. Three pins are then inserted using the method which has just been

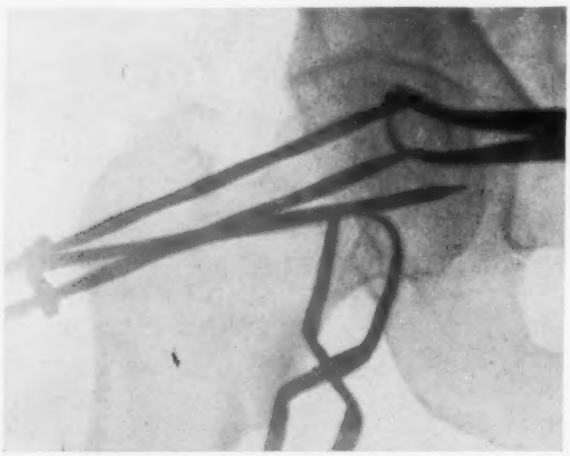

FIG. 7.—Anteroposterior view showing the pins in place. One pin is a little high. The others are well placed but the nuts are not tight against the outer fragment. Note that the upper towel clip, which has been placed over the middle of Poupart's ligament, is directly over the head of the femur.

described for directing them. The pins are held in a simple brace which has a long narrow end. In this end, a hole has been drilled and threads have been cut. The butt end of a pin can be screwed into this brace and easily held and introduced. As soon as this is done, two more roentgenograms are made. In order to accomplish this, a large sheet is thrown over the table

and the exposures can be made without contaminating the field. When these films have been inspected and it is seen that the pins are properly placed, they are then driven home. This particular matter is of very great importance. It is a well known fact, but one which has not always been appreciated in this work, that when a nail is driven through one board into another, the tendency is for the second board to be forced away from the first as the nail goes into it. It is only when the head of the nail engages on the first board that the two are finally brought together. This is accomplished with the last two or three blows of the hammer. Therefore, when it is seen that the pins have been properly placed as to direction, one can judge how much deeper they

FIG. 8.—Anteroposterior view showing pins which have been in place six months. Patient is walking. Note the points apparently going into the acetabulum but there has been no pain or difficulty whatsoever. These pins were removed soon after this picture was taken and came out with great difficulty. The pins were made of chrome steel and the nuts of brass.

should be driven in, and the nut screwed up to the distance determined. Then with a nail set, each pin can be driven home until the nut has engaged against the outer fragment and shoved it in, so as to impact the fragments. The excess of the pin is then clipped off and the wound closed.

Many of the patients are helped out of bed within a few days. Weight bearing is not permitted, but movement of the hip is encouraged. The patient is urged to walk as soon as possible with crutches, and to bear light weight on his leg at the end of about six weeks.

The results which we have obtained in a rather small series of cases are not remarkable, though we feel that they are really quite satisfactory. One difficulty in appraising any method of treatment of fractures of the neck of the femur is that it takes a considerable length of time, several years in fact, to determine the actual end-result in each case, and during that period of time some of the patients may have died of other conditions. It has also been the habit of a good many clinicians, ourselves among them, to report

results as better than they really were. In other words, if a patient was getting about at the end of a year, many surgeons might report bony union. We have been surprised, however, to find patients, who had been reported as cases of good bony union, return after four or five years for some other condition, when it was found that the hip was anything but good. The patients themselves were quite satisfied, and were walking fairly well but the roentgenograms showed a condition that was far from that which we had supposed it to be.

With these remarks in mind, we will try to appraise the results obtained in the 26 cases which we have pinned. Of these, 17 were intracapsular frac-

FIG. 9.—Anteroposterior view showing the pins in place. These have now been in about three years and are causing no trouble whatsoever.

tures of the neck of the femur and nine were intertrochanteric. In the intertrochanteric group, one died of apoplexy within a few weeks after injury. Of the eight remaining, seven have firm bony union in excellent position. The other case has good union but poor position. This was the first case in which we employed the pins, and they were not well placed. They all became loose and began to migrate. Each was removed separately through a small nick in the skin. It may be interesting to note, at this point, that loose pins have invariably resulted when the pinning was mechanically imperfect. In our experience, if a pin has been driven through good bone into good bone and solidly fixed, it has remained fast. If a pin has been improperly inserted, it has become loose. The looseness which we have seen in connection with improperly placed pins is the only evidence we have of electrolysis of bone around the metal. Each of our pins has been made of chrome steel and upon each has been threaded a brass nut. Recently, however, we have used chrome steel nuts so that only one type of metal is involved, but even so,

there have been no cases of bone absorption around the pins when the pin has been mechanically well placed.

Of the 17 cases of intracapsular fractures, two died early. We do not believe that these deaths were the result of the operation and feel certain they would have occurred as the result of any form of treatment. Of the remaining 15 cases, there are five in which we believe we have firm bony union in excellent position. The most recent of these five cases was operated upon seven months ago; the others range up to two and one-half years. There are four cases in which the head of bone has become necrotic and is gradually being absorbed. Each of these patients is walking with a cane or crutch and getting along fairly well. Each has some type of fibrous union and not one of them seems to be a candidate for reconstruction. There are two cases in which we believe we have firm union, but who have some limp. One case died of pneumonia within ten weeks after the operation. Up to that time it appeared as if she would have an excellent result. Three other cases are too recent to report as final.* One, operated upon three months ago, has no pain in her hip, handles it as though there were nothing the matter with it at all, and under our direction is bearing some weight. We believe she could bear full weight if we permitted it. Another has gone about the same length of time, but was unfortunate in having a fat infection which has kept him in bed. I believe we are getting bony union in this case. A third one was operated upon only a few weeks ago. Although he is properly pinned in excellent position, he still complains of pain. It is interesting to note that this man seems to be running the same course as was run by each of those cases in which necrosis of the head took place. We do not know this for certain, but it seems to be apparent that in those cases in which the head became absorbed there was more pain than in those in which the head remained viable. We are not certain whether or not this may be similar to an osteoporosis.

CONCLUSIONS

(1) We believe that internal fixation is a good method of treatment for fractures of the neck of the femur. Not all cases have been cured, nor can we expect to cure all cases in the future, but compared with other methods, we believe that internal fixation is the most effective yet devised.

(2) The technic of properly introducing the pins must be mastered if one is to expect success.

* Since this paper was written, two cases which were listed as being too early to report now show good bony union. One, a man, age 86, with a central fracture of the neck of the femur has an excellent result. Another, a man, age 63, with a central fracture of the neck shows good union.

LUMBOSACRAL AND SACRO-ILIAC STRAIN CAUSING LOW BACK PAIN

A REVIEW OF ONE HUNDRED FIFTY CASES

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FORMERLY we considered backache as Mark Twain said we considered the weather; namely, we talked about it much but did little about it. We knew that no one actually ever died of backache and, therefore, the sufferer from this condition received little sympathy. It is difficult, however, for any one to concentrate on his work when he is experiencing a dull backache. If one thinks that it amounts to little ask the person who has it. Backache is not a disease, but a symptom—often an outstanding solitary symptom. The patient seeks advice not alone for the pain but on account of incapacity to work. It accounts, therefore, not only for much irritability but also for much disability, frequently in the most muscular and robust laborers as well as in many office workers. In fact, I believe there is no one condition which produces more disability and economic loss and, therefore, is so costly to industry as low back pain.

As the subject of low backache has steadily acquired more prominence during the past 25 years, a perusal of the literature during that period will reveal an increasing number of contributions concerning it. Its causes are many. Some of these causes have been individualized and, because of their importance and preponderance, different clinical syndromes have evolved gradually from the so-called lumbago, once such a vague condition because so generalized. No longer are we content to pigeon-hole this condition under that caption with the hope that time and a bottle of liniment would bring about at least an amelioration, if not a complete relief of symptoms. Patients with low back pain are seen often first by the general practitioner who may not recognize the nature of the lesion and do little to relieve the pain. Consequently, sooner or later, the patients drift into the hands of a chiropractor, an osteopath, a naturopath or some other cultist who relieves them by the manipulation of their back. As there are few patients more grateful than these sufferers, henceforth they think of these cultists for the relief of all their future ailments. It behooves us, therefore, to take the subject of low backache seriously.

Because of its many etiologic factors, low back pain remains still a perplexing problem. Among its chief causes should be mentioned posture, trauma, infection, congenital anomalies and neurologic, metabolic and neoplastic conditions. Instead of one of these, several may be responsible for the disability. The majority of cases of backache will fall into three main groups: Ortho-

pedic; gynecopathic; and urologic.[10] Certainly acute and chronic sprains are responsible for the greatest number. Next to trauma in frequency as an etiologic factor comes infection; frequently the two coexist, and when they do it is difficult to even attempt to decide which is playing the more important rôle. A congenital anomaly or a faulty posture predisposes to strains or slips in the low back and greatly retards the recovery when they once occur. Neurologic, metabolic, neoplastic conditions and protrusion of an intervertebral disk must be considered and eliminated before any rational treatment is instituted. Arthritis cannot be associated very definitely with backache unless there is some acute condition present. There is no scientific proof that it is the cause of pain. The most extensive arthritis is seen in strong stevedores who have never had a backache. In this paper we shall not consider those various factors but shall confine the discussion to the so-called strains and slips of the lateral lumbosacral and sacro-iliac regions.

Anatomic Considerations.—*Lumbosacral Region:* In considering low back conditions one must bear in mind the rôle of the lower segments of the spine and especially the lumbosacral region. Here one finds innumerable anomalies and osseous variations[4] which, although asymptomatic, nevertheless contribute to render this region of the human body mechanically less strong. To these one must add structural variations of the soft tissues which are usually more difficult to demonstrate. Because of these multiple variations it is difficult for one to decide when looking at roentgenograms of the lower back what is and what is not normal.

In the review of the literature one finds a moderate degree of unanimity of opinion as to the part played by these vertebral anomalies in production of low back pain and the mechanism by which this pain may be explained.[12] Chamberlain[2] has called attention to anomalous fissures, of developmental origin, which are mistaken for small linear fractures. These anomalies and the consecutive weakness of this segment of the spine are the result of the changes this area has undergone in our development from the quadrupedal to the bipedal posture.[17] These changes make this area a weak point when, from the upright position, one assumes the quadrupedal position and to this the elements of weight lifting, rotation or twisting are added.

Furthermore, the lumbosacral region is at the junction of a flexible and mobile section of the spine with the fixed pelvis. This junction is at a variable angle which increases the instability of this region. As Smith-Petersen[14] points out, the joints of the lower back are: (1) The articular facets; (2) the intervertebral disks; and (3) the sacro-iliac joints. The articular facets are so interlocked as to give freedom in flexion and extension and to allow minimum amount of rotation. The anatomic variation of the facets not facing in the sagittal plane does not itself give rise to symptoms but results in increased mobility in rotation and, therefore, predisposes to strain. Any other anatomic variation, such as sacralization of the transverse process of the fifth lumbar vertebra, especially if unilateral, has a tendency to render the function of the lumbosacral junction asymmetrical and, therefore, predisposes to strain.

In the traumatic low back disability, which I am considering, it is surprising to notice that there is no relation between the degree of disability and the severity of the trauma producing it but that "the manner of application of the force rather than the degree of the force is the outstanding factor in these injuries."[4] Factors to be considered, although constantly varying, are also the resistance and adaptation of the back to the forces acting upon it.[9]

In the mechanism of production of these slips, one has to remember, as Troedsson[17] has emphasized, that "the stability in this area in a stooping or lifting position is to the greatest extent dependent upon the tropism of the articular facets and the direction of the articular processes of the fifth lumbar vertebra."

To understand this one must consider the comparative anatomy: "In the quadruped the superior articular facets of the sacrum lie in the horizontal plane and receive the inferior articular processes of the fifth lumbar vertebra. This overlapping gives a very effective bony support to the body weight at the sacral end as it hangs between the shoulder and the pelvic girdles. With the assumption of the erect posture in man and a consequent great loss of weight-bearing function of these processes, there has been a change in their direction as well as in the direction of their articular facets." These processes in the lumbosacral region will have a tendency to slide, especially when there is an upward pull on the sacrum such as in lifting.

Sacro-Iliac Region.—The architecture of this joint is such as to limit or minimize any rotatory movement. In fact, reasoning *a priori*, many surgeons claim that a sacro-iliac slip never occurs except as the result of a severe trauma, such as a fall from a great distance or a severe, direct blow. It has remained, therefore, a controversial subject since Goldthwait and Osgood,[6] in 1905, introduced it as a clinical entity. In 1933, Reginald H. Jackson[8] reported a number of cases not due to severe trauma. Chamberlain,[3] a roentgenologist, also believes it is a definite clinical entity, and that a relaxation of this joint can be demonstrated roentgenologically in some instances.

History.—An accurate history is always essential and at times the most important part of the procedure, especially in industrial practice or medico-legal cases in which the element of exaggeration or malingering has always to be considered. The frequency of patients simulating backache, and the difficulty often in proving the nonexistence of it, has caused this condition to be called by some "the compensation disease."[16] A detailed description of the pain, that is in relation to its onset, whether or not it was associated with a trauma, location, radiation, duration and other factors influencing it, should be elicited, as this will greatly assist in a differential diagnosis. This is often a tedious procedure. If the pain was associated with trauma, the history will often reveal that it was of a sharp character and was ushered in suddenly during a twisting movement of the spine while leaning over, lifting or pulling, when suddenly his foot slipped or a coworker, who was lifting one end of the load, let go unexpectedly, throwing the entire load on him suddenly. He was not prepared for the sudden strain and there was a lack of coordination.

Often he will tell you he heard and felt something snap. He was unable to continue with his work. The next morning on attempting to get out of bed, he again felt a severe pain. Because of it he has been unable to lean over to lace his shoes. The pain will be described usually as constant, located across the lower back or on one side, and aggravated by any movement of the lower spine.

The history and examination should be systematic and follow a comprehensive outline in order not to overlook some important information. The factor of compensation, of various sick benefits, or of litigation and the influence they may have upon the outlook of the patient, should always be kept in mind by the attending physician. Often it is necessary to obtain this information from others than the patient. The malingerer is usually very vague and varied in the description of his symptoms. To a good listener he will be profuse in his remarks.

Examination.—After a thorough history has been taken, the examination includes a careful note of their gait, the attitude of standing, method of sitting or arising from a chair.[15] Often a complete physical examination is necessary to properly evaluate the factors causing a back condition of long standing, but in the acute cases, to which I refer, the examination is usually limited to the back. The patient should have the entire back and hips exposed. One should notice the presence or absence of *postural changes* or defects, muscular atrophies and muscular spasms. If the patient is examined in bed or on a table it will be observed that he lies on his unaffected side with the affected limb flexed at the hip and the knees. The lumbosacral region will be flattened.

Areas of tenderness are elicited by palpation and percussion. Smith-Petersen, in 1924, outlined a routine examination in such cases which will be of assistance to those interested in the subject.

As Kuhns[9] pointed out, the examination of the spine should also be made both supine and prone, in a position as symmetrical as can be assumed with comfort. "Consistently localized tenderness is of the greatest importance in determining the type of lesion. Tenderness, of course, is a subjective manifestation and, therefore, its importance may be questioned. In most instances an experienced examiner can tell whether a patient's response to percussion or palpation is overdone or feigned. The moment of response is never accurately timed by the malingerer. He responds too quickly as a rule; sometimes too slowly."[5]

Movements.—They should be tested to determine their range and any degree of limitation in the three different positions: Standing; sitting; and lying.[13] Guarded motion of the spine is early assumed by the patient. In these conditions one will notice that the patients "walk with a shuffling gait, and body bent slightly forward and the lower back held rigid. It is difficult for them to sit down or get up, and almost impossible for them to take off their shoes." They complain of pain across the lower back, at times radiating to the groin or towards the buttocks on one or both sides.[17]

Diagnosis.—Only a thorough history and a careful analysis of every sign

and symptom will permit an accurate diagnosis in cases in which the low back is affected. There are many special tests in the examination of a back, which are best carried out by the patient lying down on a table. These tests are helpful in differentiating between a lumbosacral and a sacro-iliac condition.

Lumbosacral Strains.—In these the pain is over the fifth lumbar and the lumbosacral joint, and this joint resists movements of the spine in all directions. There is tenderness over the fifth lumbar and first sacral vertebrae and in both iliolumbar notches.

The tests suggestive of this condition are:

(1) Prone thrust in hyperextension test is best carried out by having patient raise himself up if possible from table. A sudden thrust over the lumbar region will produce or aggravate the pain in lumbosacral cases.

(2) Forward bending does not reverse the lumbar lordosis in lumbosacral sprains.

(3) Nachlas' sign—hyperextension of the thigh with the patient prone and the knee flexed, may produce pain in the lumbosacral joint, suggestive of a lesion there.

(4) Goldthwait's sign—inability to flex the thigh with the knee extended, does not become positive until the leg has been raised quite high.

(5) Patrick's sign—forced abduction of the flexed thigh, elicits no pain.

Sacro-Iliac Strains.—In these there is pain over the posterior aspect of the joint which becomes worse at night. If the pain is unilateral it is relieved by sitting on opposite buttocks. In extreme cases there may be some swelling over the joint. There may also be painful areas over the second, third and fourth sacral vertebrae with radiation down the sciatic nerve. The accompanying muscle spasm has a tendency to make the whole spine list, usually to the affected side.

The following tests may be found useful:

(1) Kernig's sign is positive on the affected side; with the patient lying on his back and the extended leg being flexed as far as possible on his abdomen. A normal leg can be flexed to 100°, while the affected leg can only be flexed through a much lesser range without producing definite pain. When this sign is positive it is suggestive, but not pathognomonic, as it occurs in other conditions where the sciatic nerve is involved.

(2) Straight leg raising is usually limited and painful, more on the affected side regardless of the leg tested. The pain is felt in the low back, either in the lumbosacral or sacro-iliac region. The examiner should have one hand under the lumbar region and if the pain is complained of before this portion of the spine begins to move, this reaction suggests a sacro-iliac condition.

(3) Compression of the iliac crests and pressure over the pubes may bring on or aggravate the pain in the sacro-iliac joint.

(4) Cross leg sitting test increases the pain.

(5) Goldthwait's sign is manifested immediately the heel is raised from the bed or the table.

(6) Patrick's sign is occasionally positive, pain being produced over the sacro-iliac joint.

(7) Ober's sign[11] is positive if the fascia lata is contracted. This consists in adducting the extended leg with the knee flexed at right-angles and the patient on his side.

(8) Ely's sign may be positive in sacro-iliac sprains—forcible flexion of the leg on the thigh causes the pelvis to rise off the table and produces pain.

Treatment.—In recent cases of lumbosacral and sacro-iliac strains, deep heat is applied over the lower back for 15 to 30 minutes followed by deep massage for a few minutes and then manipulation is carried out. The following procedure has been found helpful: The patient lies on his back on a narrow, firm table. He is told to relax. The manipulator, standing at the end of the table, grasps in each hand the patient's heel and ankle and slowly and gently rocks, with a rotatory motion, the lower limbs on the pelvis, reassuring the patient and thereby obtaining the relaxation desired. One lower extremity is then allowed to hang over the side of the table and the other is flexed on the pelvis in order to hold the pelvis steady. Pressure is then gently, but firmly, exerted on the limb hanging over the edge of the table for a few minutes, while counterpressure is exerted on the flexed limb. The position of the limbs is then reversed and the maneuver repeated.

The patient is then put on his side with the lower extremity, nearest to the table, extended fully and the other one flexed at the knee. Pressure is exerted downwards on the flexed knee while counterpressure is put on the shoulder of the same side so as to obtain a rotation of the spine, clockwise of the pelvis, and counterclockwise of the shoulders. This same maneuver is repeated with the patient on the other side, changing the position of the legs. During this maneuver, which must also be carried out gently but firmly, a definite snap is frequently felt by the patient and may even be audible to bystanders. When this occurs the pain usually ceases instantly, the patient is completely relieved or may feel only a soreness in the low back. The movements of the back immediately become freer, and the patient delights in trying them out, and as soon as he gets off the table will, almost invariably, bend forward, a movement which he could not make previously, to see if he can reach to his shoes.

Another simple and quick manipulation which may work well in some patients who are not too large or heavy is as follows: Stand the patient back-to-back with yourself, and then put your arms under his axillae and lean forward, lifting him up on your back, hyperextending his lumbosacral region, and then suddenly give a hump or jump which will often instantly relieve him.

In the less severe cases an elastic belting is applied to the low back and pelvis. In the more severe cases of relaxation of the sacro-iliac joint a stronger support, such as a buckskin or army belt, is ordered. This belt is placed on a level with the third sacral vertebra between the anterior superior spine and the trochanter and held in place, if necessary, by two perineal straps. The patient is then instructed in the care of his back, *i.e.*, to sleep on a hard bed which does not sag in the middle. Boards put in the middle of the bed

between the springs and the mattress will often prevent the spinal sag. As a further aid in relieving the soreness in the lower back the patient is instructed how to sit down and arise from a chair without bending the lower back. A brief course of physiotherapy, consisting of deep heat and massage, may be necessary for a short time. If the posture is poor and the tone of muscles weak, corrective exercises should be instituted. Where there is a pronounced lumbar lordosis the patient is instructed in the following: To stand, letting weight come on ball of foot rather than on the heel or arch; to contract the muscles of the leg, thigh, and buttocks; to push the pelvis forward; to draw in the abdomen; and to let the shoulders fall naturally rather than to push them back.

In more severe cases, especially old sacro-iliac strains, manipulation may be best performed under general or spinal anesthesia, followed occasionally by the application of a plaster encasement of the body, as suggested by Jackson.[8] It has seldom been found necessary, however, to apply this. In these cases manipulation consists in flexing the leg on the body until the toes reach the forehead, as described by Baer.[1] It may be necessary to perform this procedure in two or three stages, especially in old cases with adhesions and contractures. In some patients with severe pain it is often advisable to put them to bed and apply traction to the lower extremities and administer sufficient anodynes to give relief. After the plaster encasement is removed it may be necessary to substitute a short Taylor brace for it, and this in turn by a belt with a Cooke pad over the affected side.

Old cases require a more thorough investigation, especially for foci of infection. Anteroposterior, lateral and also oblique roentgenograms should be taken. If foci are found these are eliminated, if possible, or treated. Infection in the gallbladder has been known to produce so-called recurrences of "lumbago" which would cease entirely after a cholecystectomy. Infection in the prostate and seminal vesicles may be the sole cause of low backache in some patients and a contributing cause in others. In many patients the prostate is not a factor, even though a prostatitis may be present. A thorough rectal and proctoscopic examination should eliminate any pathology in the lower bowel.

CONCLUSIONS

(1) Lumbosacral and sacro-iliac strain causing low back pain is a definite clinical entity.

(2) Many of the sufferers of this condition go outside of the medical profession for relief.

(3) There are few patients more grateful for relief than the sufferers with low back pain.

(4) A very careful history and thorough examination will often lead to an early diagnosis.

(5) Of the 150 cases reviewed in this series, the youngest was age 19, and the oldest age 80. The majority were in middle life.

(6) This condition occurred more often in the strong, robust, muscular individuals.

(7) Arthritis, *per se,* was not an important factor in the production of the pain or the disability.

(8) Roentgenograms usually give little aid in the diagnosis.

(9) Low back pain is a favorite complaint of the malingerer.

(10) Trauma was the cause of the condition in the majority of the cases.

(11) The manner of the application of the force, rather than the degree of the force, is the important factor in the production of these lesions.

(12) Early treatment by manipulation, and a belt if necessary, will effect a prompt and often permanent cure in the majority of cases.

(13) A plaster of paris body encasement was applied to ten patients in the series. This form of treatment is, however, being employed less frequently by the author, although it has its indication.

(14) The disability in those treated with a plaster encasement averaged several months and was prolonged by many contributing causes.

I wish to express my appreciation to my associate, Dr. Piero Albi, for his assistance in the preparation of this paper.

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GLASS RODS AND OTHER ITEMS IN THE TECHNIC OF THE ABDOMINAL INCISION

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THERE is need to provide means of escape of virulent products of infection by Streptococci and anaerobic organisms often found in the neighborhood of a ruptured appendix. The entire care of such infection should not be left to the defensive mechanism of the peritoneum, and drainage of this highly contaminated area is, therefore, indicated. So far as the infection alone is concerned, a completely wide open wound would best serve the purpose. There are, however, other matters to consider, chief of which is the retention of the abdominal viscera within the abdominal cavity. Therefore, some form of partial closure must be effected to guard against the sudden stresses and strains induced by the acts of vomiting, sneezing or coughing. Tier suture of the wound to the region of the drain's emergence often invites disaster. In the words of Hamlet: "It will but skin and film the ulcerous place whilst rank corruption mining all within infects unseen"; an apt description of the spreading phlegmons of the abdominal wall that too often follow partial closure by tier sutures.

How, then, may we leave the wound open and at the same time brace and protect it against intra-abdominal strains?

For the past six years I have employed the method here presented with a gratifying degree of success. The illustrations depict the procedure probably better than the descriptive text. It consists, however, first, of suture of the peritoneum to within one and one-half inches of the lower end of the wound, then mattress sutures are introduced, usually two on each side alternating one with the other. The first one placed near the upper end of the wound enters the skin one inch or more from the edge of the wound, depending upon the thickness of the abdominal wall, through the fascia of the same side, across the wound, and up through the fascia only on the opposite side of the incision, then back to the neighborhood of its beginning paralleling its outward course. The second mattress suture is started from the opposite side of the wound, the third and fourth also alternating. After placing the sutures they are all lifted up, thus approximating the aponeurosis in the middle of the incision; the sutures are then tied over glass rods (Figs. 1A, B and C), which gives an easy distribution of the stress. I have found heavy braided silk the best material for these sutures. Before tying, the sutures should be slightly relaxed to provide a small gap between the edges of the aponeurosis. After tying the sutures the edges of the skin are grasped with Allis forceps and the edges held open, the wound flushed with tincture of iodine and packed loosely

with vaselined gauze. This last procedure seems to protect, in some measure, against invasion, probably on the principle of Rutherford Morison's "Bipp"

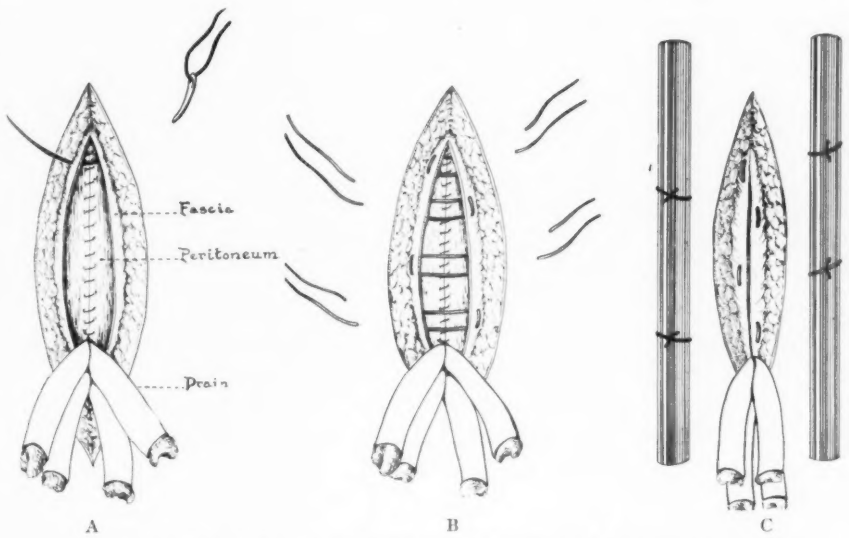


FIG. 1.—(A, B and C.) Illustrating the various phases of the suggested procedure.

paste. Release and escape, if one may use a psychiatric expression in this connection, is amply provided and fascial slough is reduced to a minimum. The vaselined gauze is removed in 48 hours, and, if there is much soiling, the

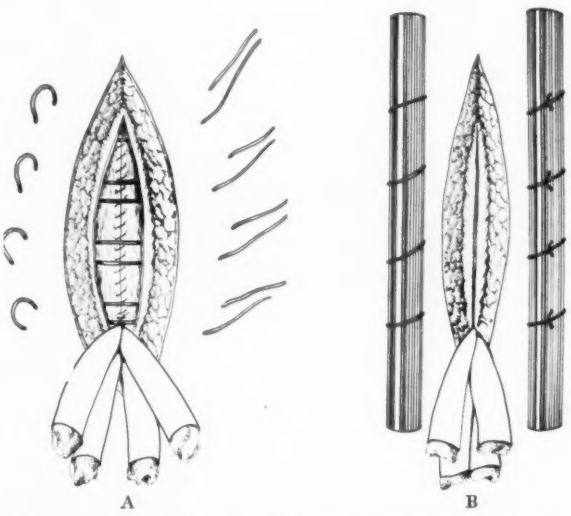
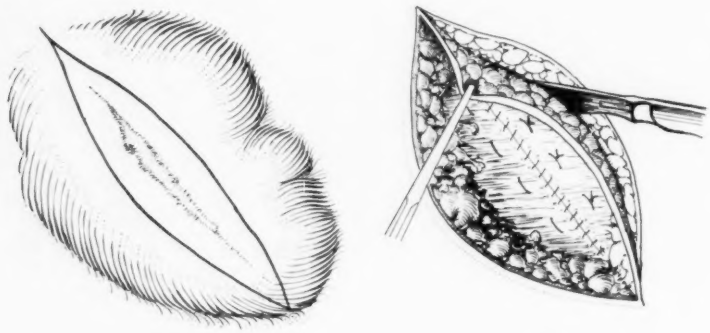


FIG. 2.—(A and B.) Illustrating the procedures employed in instances of disruption of the abdominal incision.

wound and surrounding skin are given a daily cleansing bath of tincture of green soap and sterile water. Postoperative hernia in the appendix wound is due largely to fascial slough. After six years of employing this procedure,

we have had but one instance of such a hernia. Three weeks in bed is a small price to pay for recovery with a sound abdominal wall.

Following disruption of the abdominal incision, the use of glass rods to brace the wound will be found to be useful. Here the sutures are carried all the way through both sides of the wound if the peritoneum cannot be sutured. If it can, it should be, and the procedure illustrated in Figs. 2A and B are followed.



A B

FIG. 3.—(A and B.) Illustrating the procedure employed in instances of defective healing, resulting from the presence of traumatized or excessive fat.

The frequency of infection and troublesome serous accumulations following operations for postoperative and umbilical herniae has caused me much concern. Frequently, in spite of the most careful technic, this troublesome complication has occurred. In one case of a large umbilical hernia, after the

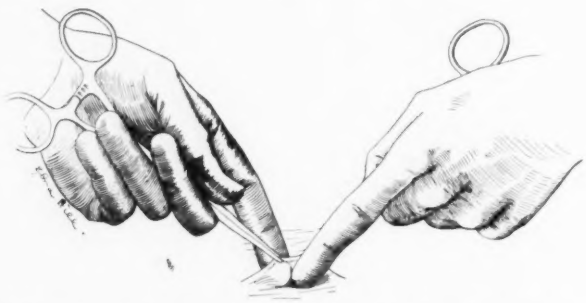


FIG. 4.—Illustrating method of avoiding injury to the underlying intestine.

aponeurosis had been plicated, the wound was flushed with normal salt solution to clear it of débris; floating in the fluid around the edges of the wound were seen many long threads of fibrous tissue, some with small balls of fat adhering to them, the remains of the septa between the lobes formed by the ectopic loops of bowel. Excision of a zone of fat all around the wound down to the aponeurosis leaves a fresh, clean, untraumatized surface that healed per primam in this and all subsequent cases (Figs. 3A and B).

Occasionally one is embarrassed to find a small slit present, which has been

made unintentionally into the lumen of the intestine. To prevent such accidents we have adopted the technic shown in Fig. 4.

The peritoneum has been grasped with two hemostats and drawn firmly upward. The forefinger of the operator and that of the first assistant are pressed downward in opposite directions on opposite sides, against the web of peritoneum picked up by the hemostats. In this way one can be quite sure that no intestine or omentum is caught when the peritoneum is opened, as these structures can be readily felt, and identified if present, in the web, and if not, they are pushed down below the level of the incision out of danger.

DISCUSSION.—DR. R. L. SANDERS (Memphis, Tenn.).—In the earlier years of my surgical practice, I employed the right rectus incision; however, during the past 10 or 12 years it has been abandoned in favor of the gridiron or McBurney incision. In practically all of our acute cases, the abdomen is opened first through a McBurney incision and if an error has been made, the incision may be quickly closed and any other type employed without any damage having been done. Such conditions rarely arise, and in almost all cases the appendix can be removed through the smaller anatomic incision.

When the appendix is perforated and drains are used, the peritoneum may be loosely closed about them and the entire abdominal wall left open for free drainage. If one closes the fascial layers, pus may burrow beneath the planes of the abdominal wall, being the lines of least resistance, and infection of the tissues may occur for some distance. In this manner, one may see a superimposed infection in the abdominal wall even after the peritonitis has been fairly well controlled. In my own work, the mortality has been definitely reduced by employing the McBurney type of incision and leaving the wound open when drainage is used. It is amazing how quickly the wound will clean up. Secondary closure is rarely necessary. When the wound has become clean it may be drawn together with adhesive plaster. Postoperative herniae rarely occur.

UVEOPAROTITIS

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UVEOPAROTITIS, or uveoparotid fever, was first described by Heerfordt[2] in Germany. Since his original report in 1909, approximately 60 cases have been recorded; of these, only four or five have been reported in America prior to 1937. Thompson[3] reported six additional cases in April, 1937, making no mention of the earlier work of Folger[1] in June, 1936. The latter reported one case in detail and gave a most adequate and comprehensive description of present views on the disease, along with a very complete bibliography, thoroughly reviewing all preceding cases and discussing fully the much argued question of etiology. In Thompson's cases, the eye findings seem fairly suggestive of the disease as originally described, but typical parotid enlargement occurred in only two instances. The inclusion of these six cases as true uveoparotid fever is open to question.

Case Report.—An unmarried colored male, age 32, was admitted to the Surgical Service of Dr. W. Estell Lee in the Pennsylvania Hospital December 14, 1936, complaining of painful, bilateral swellings of the face and dryness of the mouth.

The history of his illness dated from October, 1936, at which time he recalled a certain amount of drowsiness and sleepiness, unusual for him. He had suffered from slight dyspnea, and from a painful tooth. Toward the end of October some small vesicles made their appearance on the lower abdominal wall, and there was an exfoliative skin lesion on the anterior surfaces of both lower legs. The latter resembled the results of a mild burn. It subsequently disappeared. The patient was apparently well until the onset of a bad cold, November 24, which lasted two days, at which time there developed an earache (left ear) and a painless swelling in front of the ear. There was some question about how much pain, if any, the patient suffered in the swollen area, as his story varied on repeated questioning. The swelling gradually increased, and a similar painless swelling appeared on the right side of the face the following day, which rapidly increased in size. Hot towels were applied to the face on two successive days without effect. The patient recalled that on November 29 he felt as though "there was an orange glass in front of the left eye." On December 1 he experienced dryness of the mouth for the first time. Because of the persistence of the swelling he came to the hospital and was first examined December 9. His temperature was 99°F. He was treated symptomatically, and was instructed to use sodium perborate as a gargle. He returned December 14, rather acutely ill, complaining of pain in the swollen areas. There was tenderness over both parotids, and a slight serous discharge could be seen emerging from Stenson's ducts. His temperature was 99.1° F.

The patient had had pneumonia, measles, and pertussis, but never mumps. He also gave a history of a questionable asthmatic attack in 1929. He had sustained no serious injuries and had had no operations. The family and social histories were irrelevant.

Physical Examination, December 14, disclosed a nervous, and apprehensive, colored male with bilateral, preauricular swellings, apparently located in the parotid glands (Fig. 1). These glands were tense, nontender, and nonfluctuant. The pupils were round and equal, both reacted to light, but the right to a greater degree, and more

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promptly. Corneal opacities and posterior synechiae were noted in the left eye, but the fundus was not visualized. The nasal septum was deviated to the left, and there was hyperplasia of the left middle turbinate, along with a purulent discharge. The ears were normal. The mouth appeared dry, and the tonsils were infected. The orifices of Stenson's ducts appeared to be swollen. Examination of the heart and lungs revealed no abnormalities. The liver edge was slightly palpable below the right costal margin. There was bilateral inguinal adenopathy. The left ankle appeared somewhat swollen and slight pitting edema was demonstrable on pressure over both tibial crests. A dermatitis over the tibial crests, noted later, was overlooked at this time.

Subsequent Course.—Following admission, the patient received roentgenotherapy to the parotid areas without any apparent effect. The blood chemistry, serology, and

FIG. 1.—Appearance of the patient on admission: Bilateral parotitis.

FIG. 2.—Showing right facial palsy.

blood count were essentially negative save for a tendency toward leukopenia and neutropenia. Medical and dental consultations were obtained as soon as possible and roentgenograms were taken of the face, for possible Stenson's duct calculi, which were negative.

On December 17, right facial paralysis was first noted (Fig. 2). This was of the peripheral type and was quite complete. An attempt was made by Dr. J. R. Cameron to catheterize the ducts and thus relieve tension from within. No fluid was obtained from the right duct, and it was found impossible to introduce the catheter all the way into the left duct.

During two successive nights about one week later, the patient complained of rather severe pain in the still-swelling parotid glands. Facial palsy persisted on the right side. Treatment, other than the procedures described, consisted of purely palliative measures—soft diet, ice bags to the face, chewing gum, and rest in bed. Because of vague discomfort in the eyes and slight photophobia, he was urged to wear dark glasses.

It was concluded that the patient did not have mumps, nor a duct obstruction, but, rather a chronic inflammatory process in the gland tissue itself, or a neoplasm. Neoplasm was considered least likely, since, in this region, one most often finds teratomata. As the swelling here was bilateral, this diagnosis was unlikely.

The patient left the hospital for the period of a week (December 29, 1936 to January 5, 1937). During this time he presented himself at another hospital where he was

at first thought to have mumps. On January 1 and 2, respectively, the right and left parotid swelling began to recede. About this time, the patient noted soreness above the left eye.

He was readmitted to the Pennsylvania Hospital January 5, 1937, at which time Stenson's ducts were successfully catheterized. The catheters were left *in situ* 24 hours, but no drainage resulted. The left eye had now become quite painful, and vision was impaired. From January 15 on, the patient was constantly under the ophthalmologist's observation. The left eye gradually cleared up. From the ocular point of view, the diagnosis of uveoparotid fever seemed quite clear-cut.

During the remainder of his stay, the patient continued to improve and a number of laboratory studies were made. The parotid glands decreased in size so that by

FIG. 3.—Appearance on January 21: Showing parotitis subsiding.

FIG. 4.—Appearance on January 21: Showing evidences of the remaining facial palsy.

January 28, they were barely palpable (Fig. 3). The eyes improved subjectively, but the facial palsy remained (Fig. 4). An infected tooth was extracted February 2. On February 7, patient complained of sore throat and muscular aches. Tonsillectomy, under local anesthesia, was advised, but the patient refused operation. By February 12 the patient felt so much better that he insisted upon leaving the hospital.

He was seen subsequently in several Out-Patient Departments: (1) Because of chest pain and dyspnea, thought to be the result of a coronary occlusion (diagnosis not substantiated by electrocardiogram and subsequent course); (2) for the extraction of another tooth; and (3) for further eye treatment. The patient has not been contacted since June 23, 1937.

Laboratory Data.—Blood counts on eight occasions showed: (1) Hemoglobin constantly 90 per cent (14 Gm.); (2) red blood cells 4.95 to 6.0 million; (3) white blood cells 2,700 to 5,400 maximum; (4) differential white count, tendency to neutropenia with relative eosinophilia on one occasion. Blood platelets 400,000. Coagulation time one minute. The fragility test showed beginning hemolysis at 0.38 per cent and hemolysis complete at 0.32 per cent. Blood sedimentation rate was rapid on two occasions; namely, 25 Mm. on January 25, and 22 Mm. on February 3 (one hour's observation). Heterophile antibody agglutination showed two plus in dilution 1:16 and plus-minus in dilutions 1:32 and 1:64. The Kolmer modification of the Wassermann reaction of the serum and the Kahn precipitation test were negative. The gonococcus complement fixation test was negative.

Blood sugar determinations on four occasions were 87, 87, 77, 79 mg. per 100 cc. blood respectively. Four determinations of the blood urea nitrogen showed 8.6, 9.3, 8.1, and 8.6 mg. per 100 cc. blood respectively. Two blood cholesterol determinations showed 175 and 190 mg. per 100 cc. of blood.

Fifteen uranalyses showed only a few granular casts in six of them.

The basal metabolic rate was minus 8 per cent. An electrocardiogram showed nothing abnormal. Roentgenograms taken of the chest, sinuses, and of the face, for opaque Stenson's duct calculi, were negative. Two tuberculin tests using P.P.D. (purified protein derivative) in strengths equivalent to 0.01 and 1.0 mg. of O.T. were both negative. Cultures, taken from secretion found on the soft palate toward the end of patient's hospitalization, showed *Staphylococcus aureus* and *Micrococcus catarrhalis*.

Blood cultures were not made, and spinal tap was not performed.

Special Examinations.—Appended are excerpts from the ophthalmologic reports of examinations made by Drs. A. G. Fewell and M. L. Kauffman:

January 15.—Externally the eyes are negative. There is no inflammation of the lacrimal glands. O.D.: There are numerous fine deposits on the posterior surface of the cornea. There is no uveal pigment in the anterior capsule. Pupil dilates evenly. There is no evidence of posterior synechiae. The optic nerve is of good color. Disk margins are slightly hazed but definable. Veins are dark and full. In the extreme periphery of the upper nasal quadrant there is a choroidal lesion. O.S.: There is a well marked descemetitis and a practically complete annular posterior synechia. The pupil dilates with great difficulty and with much irregularity. No lesions could be seen in the fundus. There is weakness of the right orbicularis muscle. We do not believe this is Mikulicz's disease. It might possibly be a case of uveoparotitis. O.D. 6/12, O.S. 6/15.

January 18.—There has been no change. The right eye dilates well. The left pupil is only partially dilated and quite irregular. We are unable to break up the adhesions. It is thought that this is surely a case of uveoparotitis. O.D.: Upper nasal part of the fundus shows some old perivascular changes along with choroidal lesion. O.S.: Pupil still only partially dilated with many posterior synechiae, but in nasal fundus there can be seen a small choroidal hemorrhage and some choroidal irregularity. A smaller hemorrhage is seen in the upper temporal quadrant.

January 25.—O.D.: Pupil well dilated. Still numerous deposits on Descemet's membrane. There are fine vitreous opacities. The disk is of good color, with moderately hazed margins. The superior nasal vein shows pipe-stemed sheath from midzone out to the periphery. In the far out periphery (upper nasal) there is some old choroidal disturbance. Inferior temporal vein shows same pipe-stemmed sheath. O.S.: Deposits on Descemet's membrane remain. Pupil irregular. Many posterior synechiae. Unable to find hemorrhages in fundus today.

February 1.—O.D.: More deposits on Descemet's membrane and slight injection of the eye. No new fundus lesions seen. O.S.: Condition is subsiding, but there are still many posterior synechiae. O.D. 6/15, O.S. 6/12.

February 8.—O.D.: There are still a good many deposits on Descemet's membrane, and vitreous opacities. The choroidal lesion up and in is less marked. O.S.: Quiet. Posterior synechiae remain. There are no new fundus lesions.

The reports of the nose and throat examinations by Dr. H. B. Peacock were:

February 1.—Both drums and canals are normal. There are atrophic crusts with odor from the right nasal chamber without accompanying atrophy of the mucosa. The left side is normal. Both frontal sinuses are cloudy on transillumination, but both antra are clear. Removal of nasal crusts leaves a bleeding, tender area on the mucosa. The soft palate and uvula are dry, sticky, and inflamed, with many beads of fluid suspended over the whole. These beads brush off with a tongue depressor giving a gritty feel. The tonsils are slightly buried with rather marked evidence of chronic inflammation.

February 12.—The tonsils are chronically inflamed. Advise removal under local anesthesia.

Discussion and Comment.—The case here reported is of interest for a number of reasons. The patient appears to present a good example of a rather rarely observed syndrome. He presented an opportunity to seek the etiology of uveoparotitis. This was, however, unsuccessful. Tuberculosis remains the most likely cause. The serology was negative; there was a rather constantly observed reduction in the white blood cell count, and there was a minimal pyrexia. Tuberculin tests were negative. Allergic studies were not made, but this avenue of approach seemed fruitless. The lack of fever of consequence, the lack of leukocytosis, and the absence of purulent secretion from Stenson's ducts, and pyopia, seemed to adequately rule out an acute infectious process. The teeth and tonsils (and possibly sinuses) could have acted as foci of infection. The parotitis was not the result of duct calculi. The facial palsy was probably from direct pressure on the nerve, but it could easily have been toxic in origin.

The disease is of interest to the internist, to the ophthalmologist, and to the surgeon. The internist is concerned with its relation to tuberculosis, its possible early confusion with epidemic parotitis, and the differential diagnosis, including teratoma, syphilis, Hodgkin's disease, and Mikulicz's disease. The ophthalmologist is interested primarily in the prognosis for vision. This is usually fairly good, though, naturally, synechiae will remain. Pupillary activity, then, becomes restricted, but vision is rarely impaired permanently. Likewise facial palsy may often entirely clear up. The surgeon's attention will be centered on possible biopsy, or open drainage of the apparently much congested and dangerously enlarging glands. It may be thought that the chance of a permanent nerve palsy will be decreased by prompt surgical interference. These possibilities are mentioned to be condemned. A most earnest plea is here made to proceed cautiously, looking for eye changes, for dermatitis, for low fever, for leukopenia, before acting hastily, thereby complicating a condition which ordinarily is self-limited.

SUMMARY

(1) A case of uveoparotid fever is presented.

(2) This syndrome is characterized by parotitis, uveitis, and low-grade fever.

(3) The etiology is not known, but considerable evidence in favor of tuberculosis has been reported in previous papers.

(4) The course is mild; the prognosis good.

(5) A plea is made for early diagnosis, avoidance of surgery, and watchful waiting.

(6) There have been only about 60 cases of this syndrome previously reported in the literature.

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SPIVACK'S GASTROSTOMY

AN ANALYSIS OF THIRTEEN CASES WITH A REVIEW OF THE TECHNIC

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WHILE the operation of gastrostomy has been used for many years, the first successful operation having been performed by Sydney Jones in 1875,[1] there have always been inherent difficulties connected with its use.

The most serious difficulty, which was at first encountered, was the leakage of gastric contents from the opening made into the stomach. It was discovered that while food could be satisfactorily introduced into the stomach, there was no way of preventing its return by the same opening through which it was introduced.[2] This leakage of gastric contents produced peritonitis and death. The problem of peritonitis was solved by the performance of two-stage operations.[3] These procedures consisted of fixing the unopened stomach to the anterior abdominal wall, and of opening the stomach several days later, when sufficient adhesions had formed to prevent leakage into the peritoneal cavity. The gastric contents no longer caused peritonitis but they poured out on the surrounding skin producing painful excoriation.

An effective way of preventing leakage had to be devised before the operation could come into extensive use. Witzel,[4] in 1891; Stamm,[5] in 1894; and Kader,[6] in 1896, formed a channel from the anterior wall of the stomach which was lined with serosa. This procedure, to some extent, solved the problem of leakage but introduced a new one; namely, obliteration of the serosal lined fistula by the formation of adhesions between the two serous surfaces of the tube.

The progressive obliteration of the tube makes it increasingly more difficult to introduce a catheter through which the patient is fed. If the operation is performed for benign esophageal stricture, where life expectancy is a considerable length of time, the obliteration of the tube becomes a serious matter, because the patient cannot be fed, and is confronted by the necessity of a new operation to reestablish the communication to the stomach. Another difficulty in this type of operation is that should the catheter inadvertently be pulled out shortly after the operation, it is extremely difficult to reinsert it in the proper place, and lack of knowledge of its exact location may cause liquid food to be forced outside of the stomach into the general peritoneal cavity and cause peritonitis. This type of operation, however, has been effectively used by many surgeons.

DePage,[7] in 1901, performed a gastrostomy which had, for its outstanding characteristic, a tube made from the anterior wall of the stomach in such a manner that it was lined with mucosa when completed. This was effected

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by making a flap of the entire thickness of the stomach wall and converting this flap into a tube by bringing its two lateral cut edges together. It was then carried to the skin surface and fixed so that only the opening of the tube was visible. Beck and Carrell,[8] in 1905; Hirsch,[9] in 1911; and Janeway,[10] in 1913, each performed a gastrostomy with a tube which was lined with mucosa. The mucosal lined tube did not become obliterated because no ad-

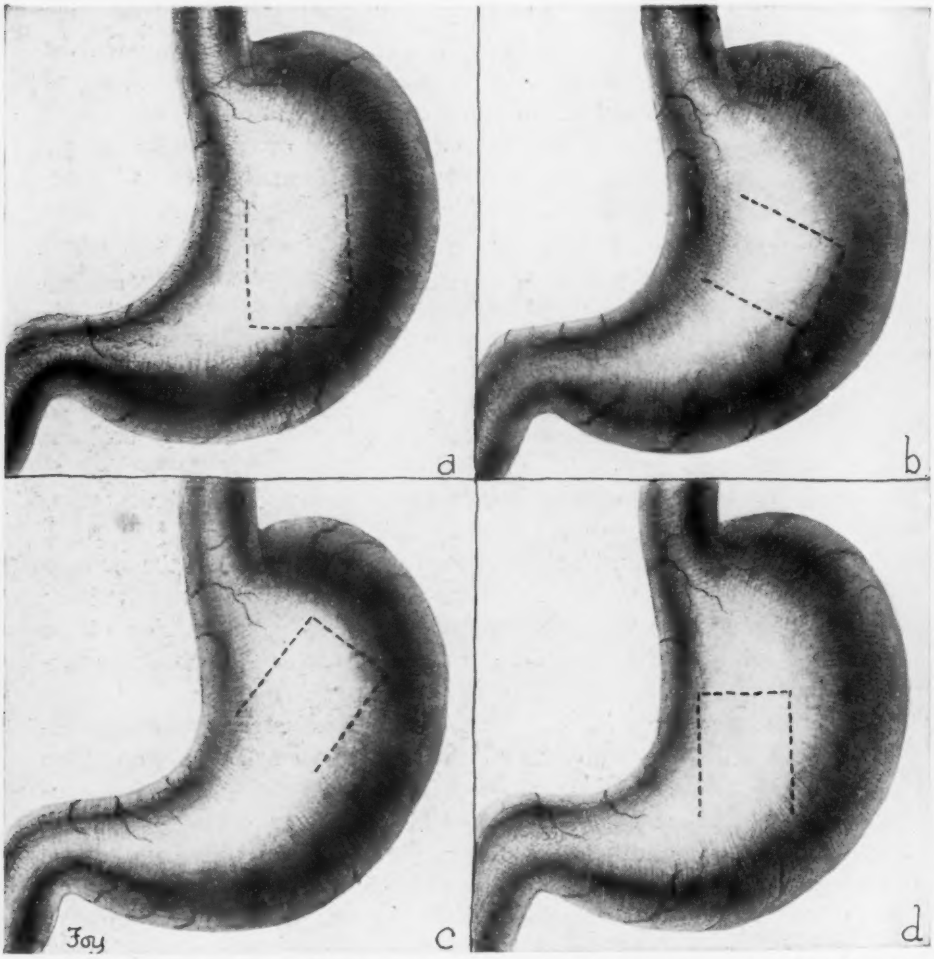

FIG. 1.—Outlines of variously directed flaps on the anterior wall of the stomach. (a and b) Janeway flaps; (c) Hirsch flap; (d) DePage flap.

hesions formed between the two apposed surfaces. However, this type of gastrostomy, unfortunately, reintroduced the problem of leakage from the stoma. The problem of maintaining an unobliterative mucosal lined tube and of preventing the leakage of gastric contents was effectively and ingeniously solved by Spivack,[11] in 1929. This was accomplished by forming a valve from the mucosa of the stomach which was placed at the base of the mucosal lined tube. The valve allows food to be introduced into the stomach through

the mucosal lined tube and once inside, the stomach cannot return its contents past the valve. As the intragastric pressure increases, the valve closes; once the valve is closed, a further increase in intragastric pressure tightens the valve.

Sufficient time has now elapsed since the introduction of this method to judge its value and to determine its advantages and disadvantages. It has

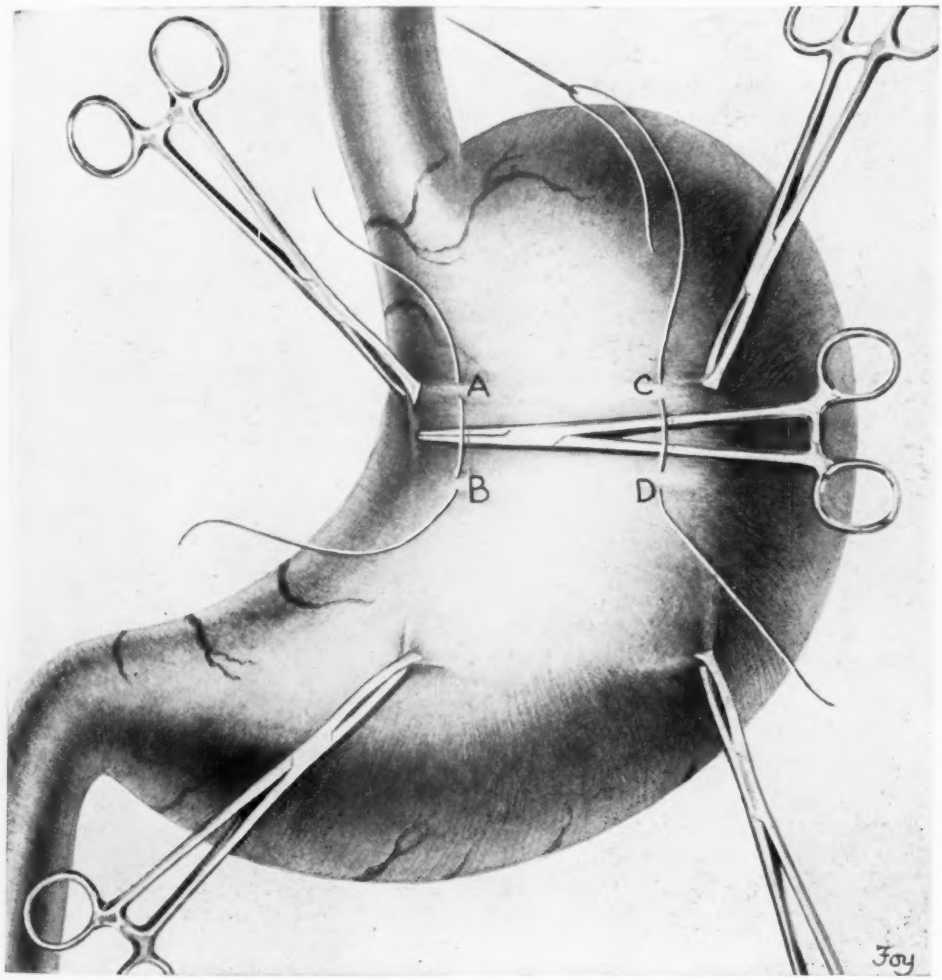

FIG. 2.—Spivack tubovalvular gastrostomy. Doubling the anterior gastric wall.

proven to be an ideal method of gastrostomy, enabling patients to live comfortably for a period of weeks or months (in cases in which it was undertaken for carcinoma of the esophagus) and for years in those in whom it was performed for benign stricture of the esophagus. It is the purpose of this article to present a series of patients operated upon by Dr. Spivack and other surgeons using this method, pointing out the advantages, disadvantages, and pitfalls of the procedure.

The first three cases upon whom Doctor Spivack performed gastrostomies were reported by Lowry and Sorenson,[12] and are included here as Cases 1, 2 and 3.

CASE REPORTS

Case 1.—The first patient operated upon had an aneurysm of the aorta which was compressing the esophagus. The operation was performed under regional and splanchnic

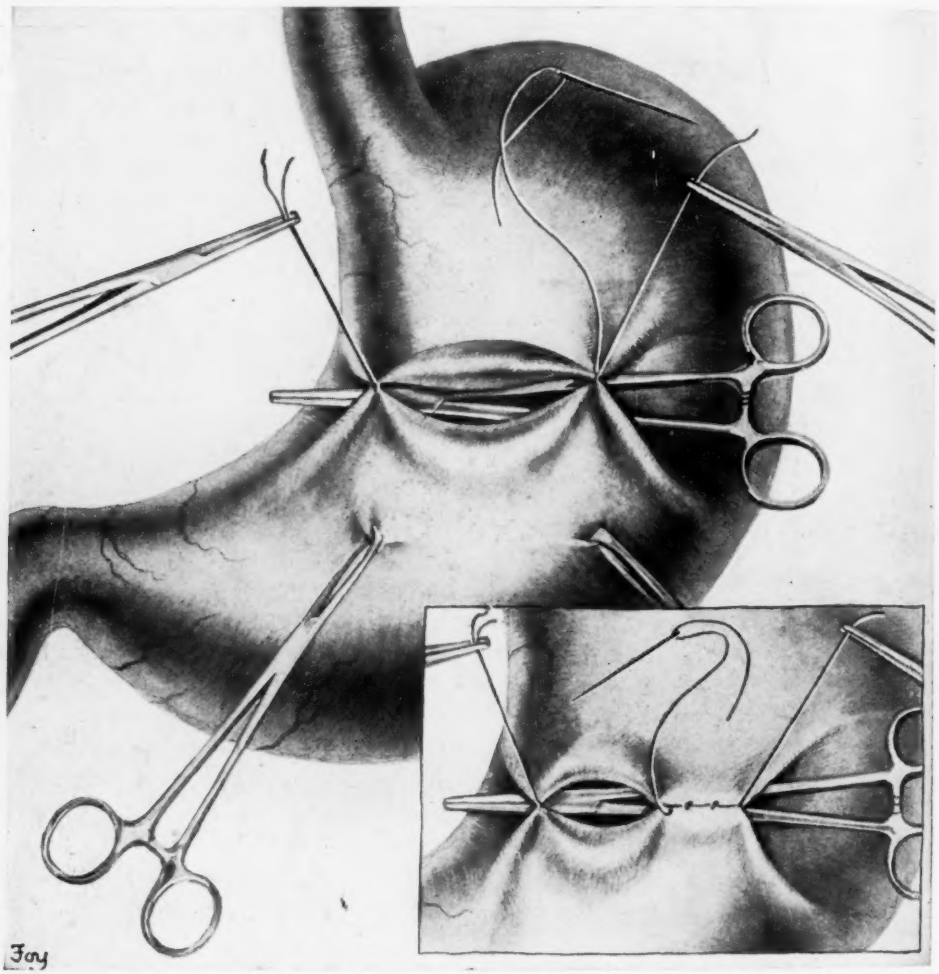

FIG. 3.—A complementary illustration to Fig. 2 showing the manner of completing the doubling of the anterior gastric wall.

anesthesia. During the operation the patient vomited, but in spite of the fact that the stomach content was able to force its way through the compressed esophagus, it was unable to force its way out past the valve which had been made at the base of the tube in the tubovalvular gastrostomy. This showed that the stomach was water-tight. The patient died 16 days later from lobar pneumonia.

Case 2.—The second patient was operated upon for malignant stricture of the esophagus. He was still living 18 months after the operation and quite comfortable; no leakage and no skin irritation were present. For three of these 18 months he was able

to feed himself through the mouth and did not use the gastrostomy stoma, but in spite of the fact that the gastrostomy tube was not opened for three months there was no change in its condition. This proved that the mucosal lined channel leading to the stomach did not become obliterated.

Case 3.—The third patient was operated upon for carcinoma of the cardiac end of the stomach. She died 14 months later from general carcinomatosis. Autopsy re-

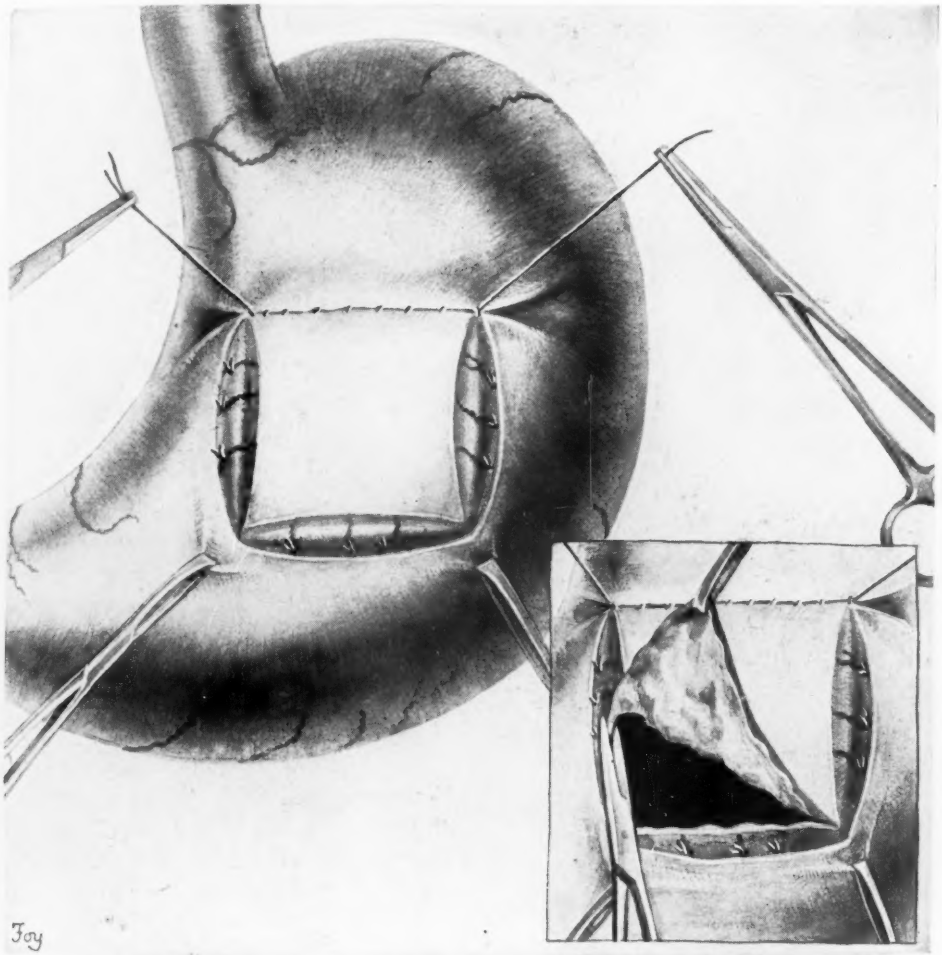

FIG. 4.—Showing the completion of the seromuscular incision. Insert illustrates the opening of the stomach.

vealed that the whole stomach including the tube was involved in the carcinomatous process but the valve at the base of the tube was still intact and water-tight.

Case 4.—In March, 1932, three years after the original description of the gastrostomy, Doctor Spivack operated upon a patient with carcinoma of the cardiac end of the stomach. In this instance, the stomach was found to be very small and contracted, and after the valve had been made from the anterior wall of the stomach there was very little stomach wall left to be utilized for the formation of the tube. In order to overcome this difficulty the gastrocolic ligament was cut through and the posterior wall

of the stomach was drawn up for a distance of one inch through this opening. This permitted a satisfactory flap for the formation of the tube. After the tube was formed, the gastrocolic ligament was replaced and resutured to the stomach. The patient made an uneventful recovery and during the first three weeks gained 15 pounds. He lived for nine months after the operation.

Case 5.—L. M., a male, age 54, entered Cook County Hospital in September, 1934, with symptoms of dysphagia, vomiting, pain in the chest, and cough. Blood pressure was 144/100. Urine, negative. Blood Wassermann, negative. Roentgenologic examination showed a carcinoma in the middle third of the esophagus. Esophagoscopy revealed a bleeding, cauliflower mass. A Spivack gastrostomy was performed upon the patient September 14, 1934. A local infection occurred which cleared up satisfactorily and he was discharged from the hospital November 9, 1934, with the gastrostomy functioning well. He was able to feed himself without difficulty. He returned two months later, emaciated, because he was unable to introduce food through the gastrostomy stoma. He gave a history of having lost a catheter through the gastrostomy opening, which was recovered in the stool several days later. On a 2,500 calorie diet, in

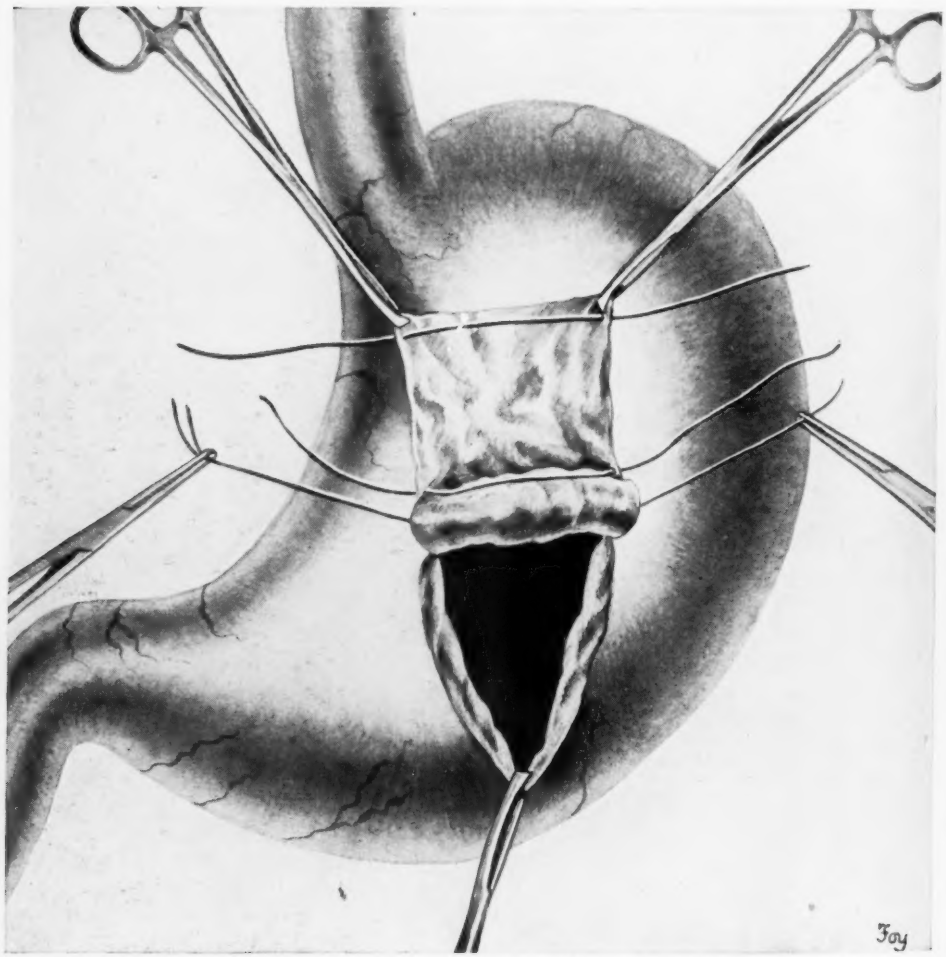

FIG. 5.—Showing the valve being exposed and the beginning of the construction of the tube.

the hospital, he gained seven pounds in one month and was again discharged. He lived until July, 1935, when he died of metastases, ten months from the time of operation, during which period the gastrostomy functioned well, without leakage, obliteration, or skin excoriation.

Case 6.—P. G., a female, age 39, entered Cook County Hospital in June, 1936, with a history of the ingestion of lye, four months prior to entrance, followed by progressive dysphagia and a loss of 40 pounds. Physical examination revealed an extremely

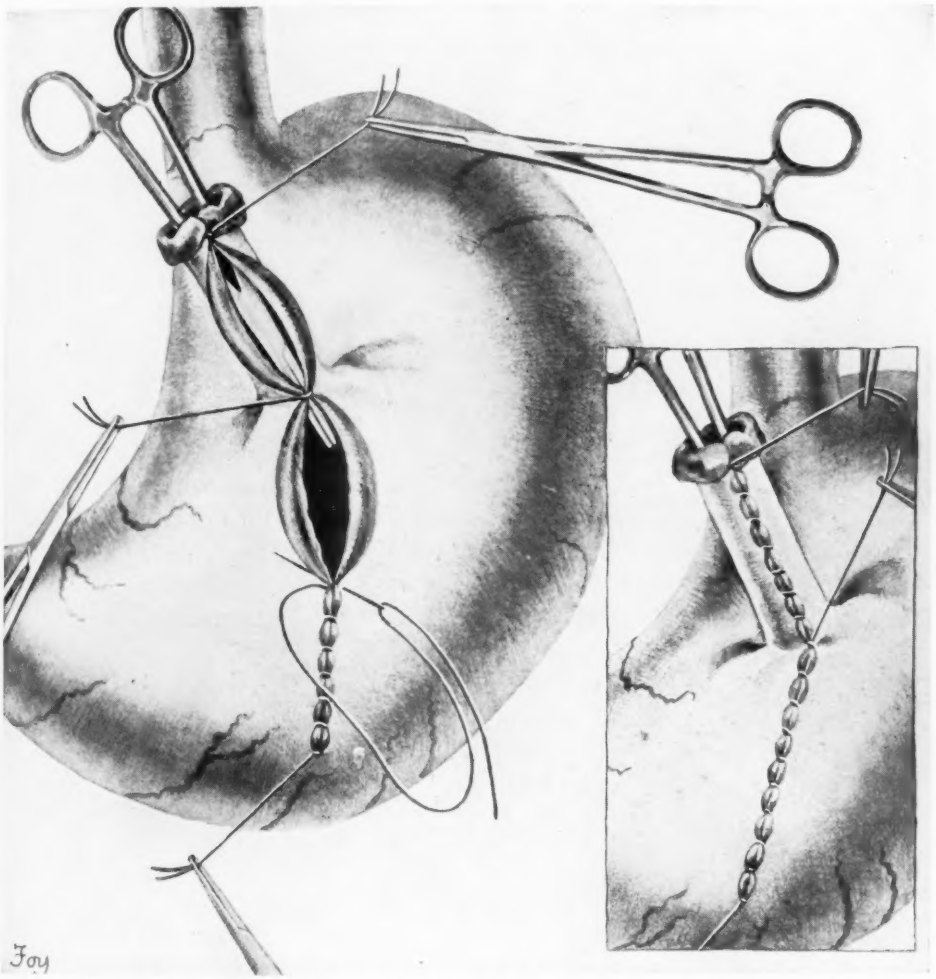

FIG. 6.—Showing the suturing of the tube and the closure of the opening in the stomach.

emaciated female. Urine, negative. Blood Wassermann, negative. Roentgenologic examination revealed a stricture in the middle third of the esophagus. A diagnosis of benign stricture of the esophagus, due to the ingestion of lye, was made, and she was operated upon June 13, 1936. A Spivack gastrostomy was performed. She made an uneventful recovery and left the hospital 17 days after the operation. She is still alive, ten months after leaving the hospital. She is able to feed herself, introducing the catheter only at mealtimes. There is no leakage of gastric contents. The gastrostomy opening is about the size of a ten cent piece, located in the left upper quadrant of the

abdomen. It is moist and there is no sign of skin excoriation, or local infection, in spite of the extremely unsanitary surroundings in which she lives.

Case 7.—R. R., female, age 51, was admitted to the Michael Reese Hospital February 10, 1937, with the history of having had a thyroidectomy performed in 1927, and again in 1931 at which time a malignancy of the thyroid was discovered. Three months prior to entering the hospital the patient had had increasing difficulty in swallowing food and hoarseness was very marked. Physical examination showed three masses in the

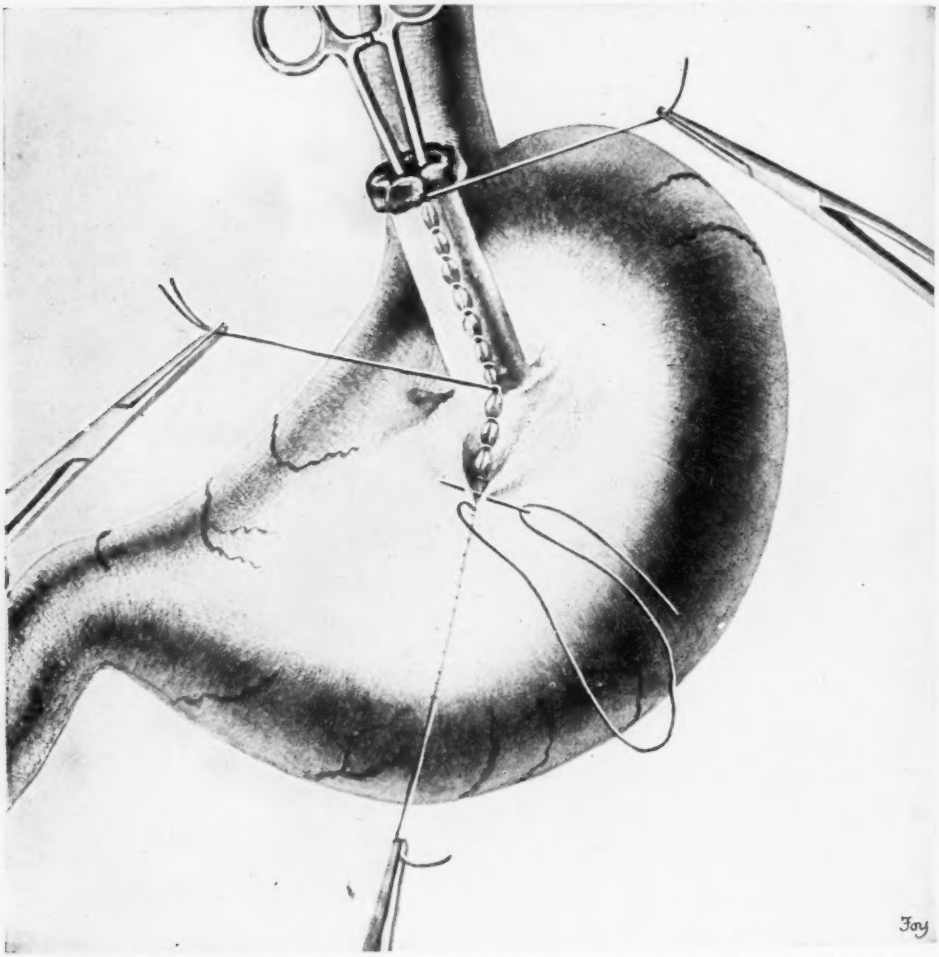

FIG. 7.—Showing the insertion of the seromuscular suture layer on the wall of the stomach and on the tube.

neck, matted together, in front of the sternomastoid muscle. Direct laryngoscopy revealed a subglottic submucosal mass protruding into the trachea. On February 25, 1937, because of the dysphagia, a Spivack gastrostomy was performed. On March 5, 1937, the gastrostomy was working perfectly. The patient was receiving a high caloric diet through the tube and gaining weight. She was discharged March 24, 1937, with a good functioning gastrostomy.

Case 8.—R. B., a female child, age two and one-half, entered Cook County Hospital in March, 1936, and gave a history of having had whooping cough four months prior to her entrance. Three months prior to entrance she had swallowed a pin which was

coughed up shortly after swallowing it. Vomiting increased as the whooping cough subsided and continued to the time of entrance. She had lost considerable weight and was very much emaciated when first seen. A benign stricture of the esophagus was diagnosed and a Spivack gastrostomy was performed April 10, 1936. She had an uneventful recovery and gained weight rapidly on a high caloric diet, administered through the gastrostomy opening. She is alive and well, one year after the operation.

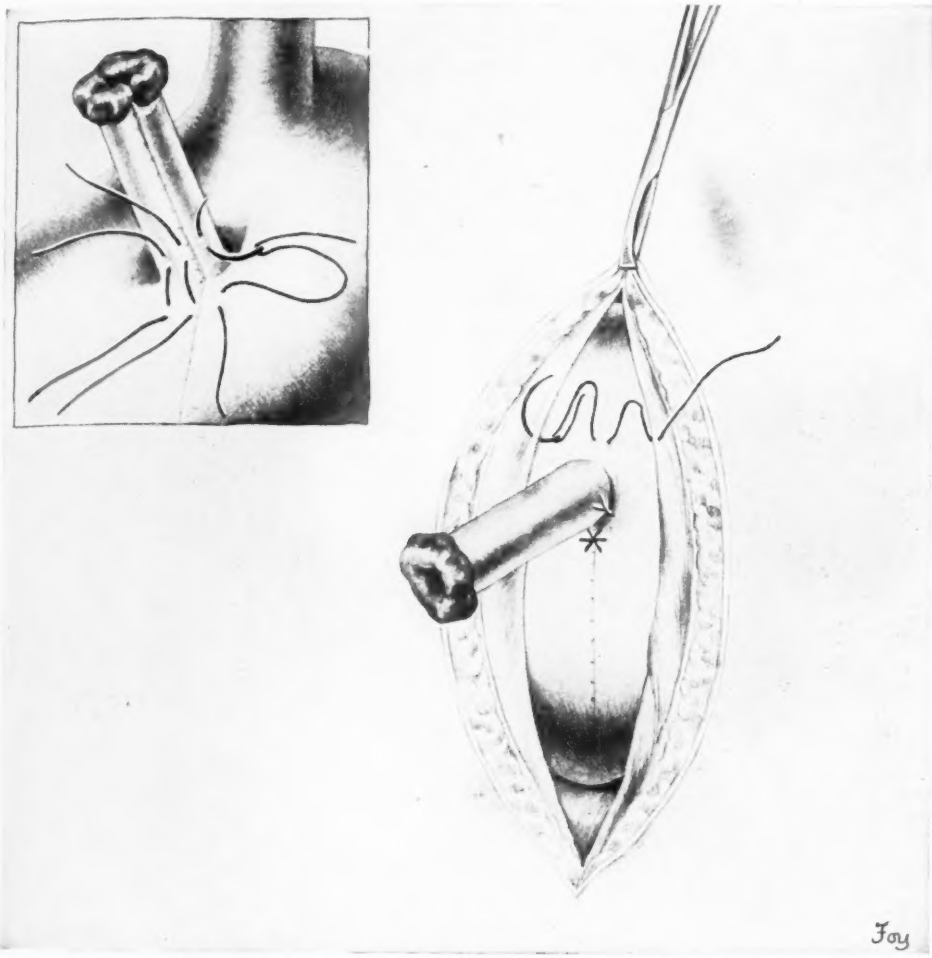

FIG. 8.—Showing the suturing of the stomach to the parietal peritoneum. Insert illustrates the making of a cuff around the base of the tube.

There is no leakage of gastric contents, no obliteration of the tube and no skin excoriation. The gastrostomy opening is easily cared for by the nurses, requiring only a small dressing between feedings, and she is fed, readily, by the introduction of a catheter at mealtimes. She is being kept at the hospital for the purpose of dilating the stricture of the esophagus.

The value of using the Spivack type of gastrostomy as a preliminary operation to esophageal dilatation, or other operations, has been frequently stressed. The following cases illustrate this point:

Case 9.—J. G., a male, age 67, entered Cook County Hospital in June, 1935, with a history of dysphagia, vomiting, abdominal pain, and a loss of 40 pounds over a period of eight months. The physical examination showed only extreme emaciation and epigastric tenderness. Blood Wassermann, negative. Urine, negative. The stool showed gross blood. Roentgenologic examination revealed a stricture at the lower third of the esophagus due to carcinoma. A thoracic exploration was decided upon and, on June 11, 1935, a preliminary Spivack gastrostomy was performed. The patient was easily

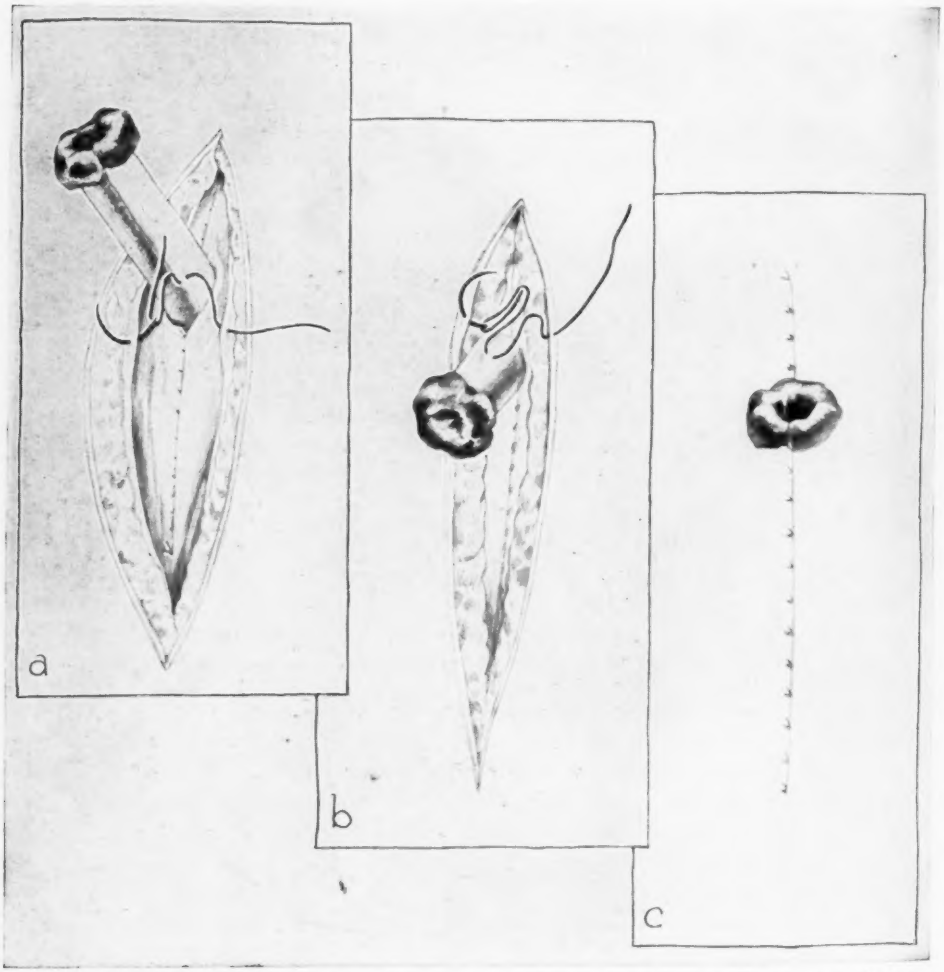

FIG. 9.—Showing: (a) The suturing of the anterior sheath to the tube. (b) The suturing of the subcuticular layer to the tube. (c) Final appearance.

fed and gained weight rapidly, so that a thoracic exploration was possible 27 days after the gastrostomy. However, the patient was unable to survive the thoracic exploration and expired the following day.

Case 10.—J. M., a male, age 52, entered Cook County Hospital with a history of dysphagia, vomiting, and a loss of 49 pounds over a period of four months. The physical examination showed extreme emaciation. Red blood count, 4,200,000. The urine showed a trace of albumin. Blood Wassermann, negative. Roentgenologic examination revealed a stricture of the middle third of the esophagus due to carcinoma.

A Spivack gastrostomy was performed February 19, 1936. Following the operation the top of the artificially made tube became infected and part of it sloughed away on the fifth postoperative day. One month later, the gastrostomy was satisfactorily healed and functioning well in spite of the absence of the upper end of the tube. The patient was able to feed himself. There was no leakage of gastric contents. He returned May 23, 1936, complaining that the opening had become so contricted that he was unable

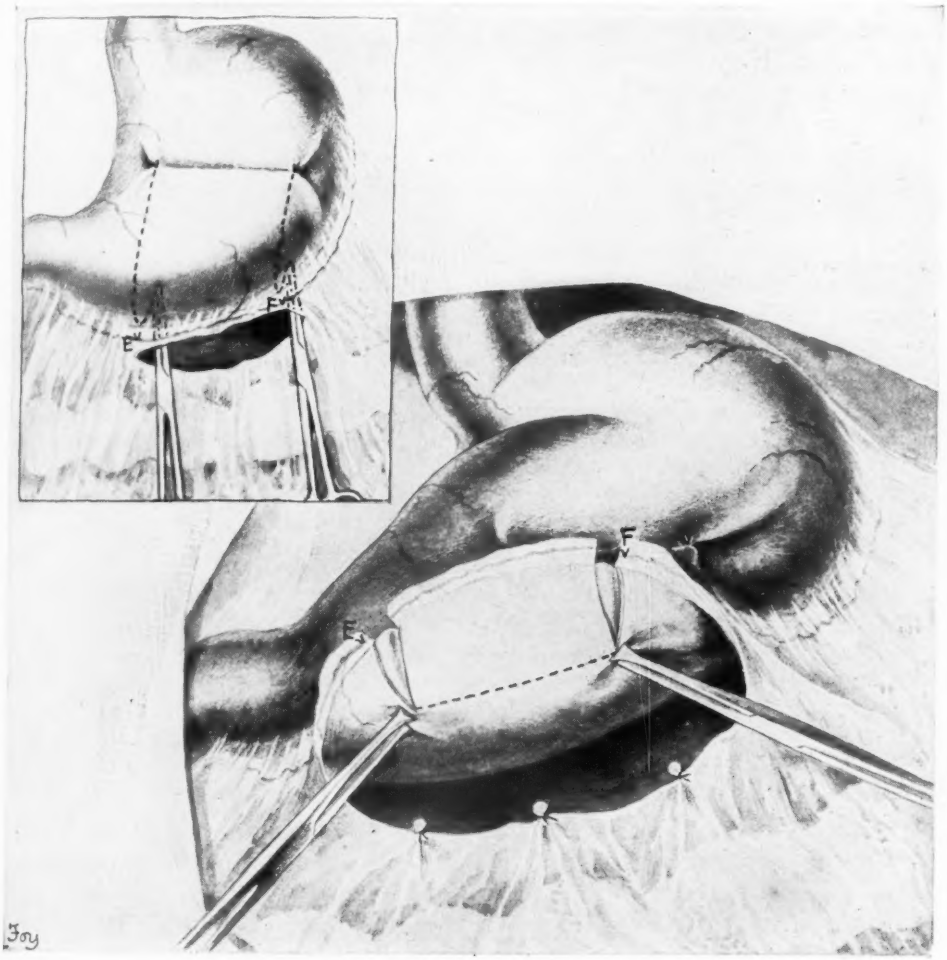

FIG. 10.—Showing the utilization of a part of the posterior stomach wall in those cases in which the stomach is small and contracted.

to feed himself. A catheter was passed into the stoma, which was easily dilated and continued to function. The patient lived for 12 months.

This case demonstrates the danger of infection, or gangrene of the tube. It also demonstrates, once more, the effectiveness of the water-tight valve present at the base of the tube. The tube may be partially sloughed away and still not greatly interfere with the function of the gastrostomy. Spivack demonstrated the effectiveness of this valve by performing a complete gastrectomy

upon a dog upon whom the gastrostomy operation had previously been performed. The esophageal and pyloric openings of the excised stomach were carefully closed and the stomach was then distended with water. The gastrostomy tube was cut off just distal to the valve and the stomach turned upside down, but no water leaked out past the valve. Considerable pressure was made on the distended stomach but the valve still prevented water from escaping.

The reliability of the valve is made use of when it is desired to use the gastrostomy as a temporary opening into the stomach or when it is necessary for some reason to close the gastrostomy opening. When the gastrostomy is no longer of any use, it may be closed by simply freeing the tube from the skin and surrounding fascia, cutting off the excess part of the tube above the valve and then closing the open tube by sutures. The valve still remains intact and prevents the formation of a diverticulum of the stomach.

The following case demonstrates the successful closure of the gastrostomy opening following leakage:

Case 11.—J. N., a male, entered Cook County Hospital in September, 1934, because of dysphagia and loss of weight caused by a carcinoma of the lower third of the esophagus. A Spivack gastrostomy was performed September 7, 1934. During the postoperative course the gastrostomy opening retracted beneath the skin but in spite of this he was able to feed himself with a catheter, and was discharged from the hospital with a good functioning gastrostomy on the nineteenth postoperative day. He returned two months later stating that he was able to take fluids by mouth but that the stoma leaked. The gastrostomy tube was dissected free, part of it was cut off, and the remainder was closed by suture. The patient made a satisfactory recovery and had no more leakage of gastric contents.

Case 12.—A. J., a male, age 58, entered Cook County Hospital with the complaint of dysphagia for one month. Roentgenologic examination showed a constricting malignancy at the middle third of the esophagus. An esophagoscopic examination showed a fungating mass. A Spivack gastrostomy was performed and a catheter introduced at the time of operation which was not removed. During the first fifteen days postoperative there was constant leakage from the tube around the catheter. The catheter was then removed, but leakage continued.

The procedure of leaving a catheter in the mucosal lined tube at the time of operation defeats the very purpose of the operation. There is a valve at the base of the tube which can be opened only by pressure from above. Pressure from below, *i.e.*, from inside the stomach, closes the valve. A catheter left in the tube makes pressure on the valve from above and keeps it constantly open. Leakage of stomach contents naturally then occurs around the catheter. After the catheter remains in place several days, necrosis may occur around it because of pressure. The valve itself then becomes ineffective. The originator of the operation has repeatedly warned against this procedure.

Case 13.—E. W., a female, age 58, entered Michael Reese Hospital, November 23, 1935, with a history of inability to swallow anything but liquids for four months. Physical examination showed a mass above the sternal notch the size of a marble, firm and freely movable. The esophagoscopic examination showed a fungating growth present on the posterior wall of the pharynx at the level of the cricoid cartilage. A biopsy showed it to be a squamous cell carcinoma. Radium therapy improved her condition for a time,

but, in September, 1936, a gastrostomy was found to be necessary in order to permit her to obtain sufficient food to sustain life. On September 4, 1936, at operation, a small atrophied stomach presented itself. A Stamm gastrostomy was performed. She was discharged September 18, 1936, but returned, November 14, 1936, with sufficient dyspnea to necessitate a tracheotomy. At this time she remained in the hospital and the following notes are taken from the hospital record:

1–4–37—Gastrostomy leaking around the tube.

1–17–37—Still leaking around tube, soaking dressings.

1–21–37—Pezzer catheter introduced and clamped.

1–31–37—Catheter slips out often. Opening is larger and leakage is occurring.

2–14–37—Advise closing present gastrostomy and making a Spivack tubovalvular gastrostomy.

3–18–37—Spivack gastrostomy performed.

3–26–37—Gastrostomy working perfectly.

4–13–37—Gastrostomy functioning well. Discharged.

This case demonstrates the possibility of replacing a nonfunctioning gastrostomy with a Spivack type of gastrostomy which is water-tight and prevents further leakage. This may be accomplished, as it was in this case, even on a small stomach.

The success of the operation depends upon a careful attention to the details of technic. The technic is so clearly explained in Spivack's "Surgical Technic of Abdominal Operations"[3] that it is repeated here verbatim:

"In this operation a tube and valve are formed from a flap of the anterior wall of the stomach (Fig. 1A, B, C, D).

"Step 1. A quadrangular area is outlined, in any direction, on the anterior wall of the stomach, three inches long and two inches wide (Fig. 1). An Allis forceps is placed at each angle of this quadrangular area (Fig. 2). (It should be emphasized here that although Spivack made his flap as a reversed U (∩), nevertheless, this is not an essential feature of his method.)

"Step 2. A seromuscular suture is made between the points A and B, and C and D (Fig. 2). The distance between A and B, or C and D, is from one to one and one-third inches. An artery forceps is placed behind the threads connecting A with B and C with D. The ends of the thread which connects A with B are tied and clamped. The ends of the thread which connects C with D are also tied, and an artery forceps is placed on one end of the thread and with the other end of the thread on the needle the next step is performed (Fig. 3).

"Step 3. The two ridges thus formed are sutured together by a continuous seromuscular suture (Fig. 3). Thus, the upper half of the flap is doubled. The artery forceps, or probe, lying behind the bridge is now withdrawn.

"Step 4. Two seromuscular vertical incisions connecting the points A-B and C-D with the lower angles of the quadrangular area are made, and also a transverse incision connecting these lower angles with each other (Fig. 4). In order to prevent the contraction of the seromuscular layer while making the transverse incision, each lower angle of the flap is caught by an Allis forceps before the transverse incision is made. If large blood vessels are

seen on the mucous membrane they may be ligated before the mucosa is opened. We prefer to ligate only the blood vessels which lie close to the stomach wall and not those which are close to the flap. Still, if desired, they all may be ligated before the mucosa is incised (Fig. 4).

"Step 5. The exposed mucosa is cut and the flap reflected. A valve at the base of the flap is then clearly seen (Fig. 5). Two buttonhole sutures are then made, one penetrating the upper two corners of the flap, and the other passing through two points at the base of the flap (Fig. 5). The ends of both are tied and clamped. The lower angle of the stomach incision is grasped by an Allis forceps (Fig. 5). The ends of the two previously made sutures, which are the beginning and the end of the seromuscular suture, which connected the ridges to each other, are now cut short.

"Step 6. An artery forceps is inserted into the stomach through the tube thus formed. The opening into the stomach is closed by an over-and-over suture, as are also the lips of the tube. When the first layer is completed it is reenforced by a second seromuscular layer (Figs. 6 and 7).

"Step 7. The weak spot at the junction of the suture line of the tube with that of the stomach is now reenforced by three interrupted seromuscular sutures (Fig. 8).

"Step 8. The anterior wall of the stomach is sutured to the parietal peritoneum. A bite is taken on the parietal peritoneum and the posterior sheath of the rectus muscle of one lip, then through the seromuscular layer of the stomach at a point just below and proximal to the base of the tube and then through the peritoneum and transversalis fascia of the other lip, and the ends are tied. The same is done to connect the peritoneum and the transversalis fascia of one lip with the stomach at a point lying below and distal to the base of the tube and then with the peritoneum and the transversalis fascia of the second lip. Before tying the thread, care should be taken to see that the tube is not constricted (Fig. 8). The rest of the peritoneal cavity is then closed in the usual manner.

"Step 9. The wall of the tube is then sutured to the muscles and to the fascia in the same manner as described in Step 8 (Fig. 9A).

"Step 10. The skin is attached to the tube in four places (Fig. 9B). The sutures penetrate the subcuticular layer of one lip of the skin and then the seromuscular layer of the wall of the tube at a distance about half an inch from its open end, so that a portion of the tube will protrude above the surface of the skin, thus eliminating the danger of retraction of the mouth of the tube below the skin surface. The mucosa covers the portion of the tube which protrudes above the skin in the form of a rosette (Fig. 9C), thus preventing the harmful action of the air upon the serous layer of the protruding portion of the tube."

A tube is thus formed, which is lined with mucosa and therefore, the canal will not become obliterated. The valve at the base of the tube assures the water-tightness of the stomach.

Being confronted with a case of a very small and contracted stomach Spivack modified his usual technic in the following manner:

"Step 3. The crests of the two ridges were united by a continuous seromuscular suture. The gastrocolic ligament was cut between the points E and F, and part of the posterior wall of the stomach was drawn out (Fig. 10). The gastro-epiploic artery (or arteries) were ligated between two ligatures at E and F (Fig. 10).

"Steps 4, 5, 6 and 7 were performed as described above.

"Step 8. The gastrocolic ligament was sutured to the stomach at the places where it was cut in Step 3 (Fig. 10). In this variation the posterior wall is also utilized for making the tubovalvular gastrostomy."

This tubovalvular apparatus can be applied not only to the stomach but also to any hollow viscus such as the bladder, cecum, colon and jejunum.

COMMENT.—The advantages of Spivack's method of gastrostomy are manifested in the patients who lived for a considerable length of time with a functioning gastrostomy. In these patients: (1) There was no leakage of gastric contents with the accompanying disagreeable skin excoriations. (2) There was no obliteration of the channel so that the patient could always be easily fed. (3) The surgeon had no fear of a catheter being inadvertently pulled out by the patient, or attendant, immediately after the operation with the accompanying difficulty and danger of reinserting it. (4) The patient had no need to keep a catheter in his abdomen constantly, with its accompanying discomfort. All that was needed was to place the catheter into the stomach at the time of feeding. (5) The patients could feed themselves easily, without the assistance of a medical attendant, so that constant care was unnecessary. (6) The stoma was small and the mucosa was moist, permitting easy management, with a simple small dressing applied over it. (7) The gastrostomy could be used as a temporary procedure for preparing the patient preliminary to other operations, after which it could be simply and easily closed under local anesthesia.

Most of the disadvantages of the operation are not inherent faults of the operation, but are due to pitfalls which may occur as a result of improper execution of the technical details.

These pitfalls are that:

(1) The stomach may not be absolutely water-tight if the size of the valve at the base of the tube is too small. To obtain the correct sized valve, careful attention must be paid to the flap selected from the anterior wall of the stomach. The flap should be three inches long and two inches wide. At least one and one-third inches of the available three inches of the flap should be used for the formation of the valve, *i.e.*, the part of the flap from which the valve is formed should be slightly less than one-half of the entire flap. Failure to respect this point will result in an unsatisfactory valve. In some cases the anterior stomach wall is too small for a satisfactory flap but in

these instances, it has been shown that part of the posterior stomach wall may be used in addition to the anterior wall (Fig. 10).

(2) While sewing across the flap for the purpose of making the valve, there is a tendency to infold an increasingly greater amount of the remainder of the flap. This results in the remainder of the flap becoming shorter on one end than on the other. When the tube, which is made from this irregular flap, is finished, it will be found to be deformed. This error is obviated by carefully sewing in a straight line across the flap one and one-third inches from the top.

(3) Part of the tube may become gangrenous and slough away. This may be due to one of two causes: First, there may be an insufficient blood supply to the flap. Studying each stomach individually before carrying out the making of the flap, with attention to assuring the pedicle of the flap with an adequate blood supply, should eliminate this difficulty. Second, the tube may be constricted by suturing it too tightly between the layers of the anterior abdominal wall.

(4) Leakage is possible at the point where the suture line on the stomach meets the suture line on the tube. Cases have been reported in which leakage occurred at this point. The originator has never met with this complication in any of his cases; in order to overcome it he considers it necessary to carefully invaginate the base of the tube by making a "cuff" around it as is described in the technic (Step 7).

(5) Retraction of the stoma of the tube below the surface of the skin may occur unless the tube is separately sutured to the different layers of the anterior abdominal wall.

(6) Before closing the anterior abdominal wall it is important to suture the stomach to the peritoneum. Adhesions between the stomach and peritoneum then form, and the weight of the stomach is not carried by the tube If this is not done, the weight of the stomach may exert sufficient pull to cause a rupture of the line of suture near the valve. Another advantage of suturing the stomach to the peritoneum is that it makes all later manipulations around the tube extraperitoneal procedures and greatly diminishes the possibility of peritonitis.

(7) The mucosa of the distal end of the tube should always overlap the serosa for at least one-fourth inch so that a rosette will be formed. In this way the serosa will not be exposed to the air and it will not dry. The exposed mucosa does not secrete sufficient gastric juice to cause skin excoriations but it always keeps moist.

(8) To prevent the spilling of gastric contents, as the catheter is pulled out of the tube, a gauze should be placed around the tube at each feeding.

(9) Spivack's gastrostomy can in most instances be performed under local anesthesia. In view of this consideration, the fact that it takes longer to perform than the generally accepted gastrostomies (Stamm, Witzel, Kader) is not regarded as a disadvantage.

(10) To avoid injury to the newly changed structures, no food should

be given via the tube for two days. On the third postoperative day, two ounces of liquid food every three hours may be administered through the tube. On the fourth day the feedings may be increased to four ounces every three hours. On the fifth day food may be added as tolerated. If there is distention, a catheter may be momentarily introduced into the stomach for purpose of decompression.

SUMMARY

(1) The advantages, disadvantages, and pitfalls of a gastrostomy described by Spivack are discussed.

(2) Thirteen cases are reviewed to show the application of the gastrostomy to different problems in stomach surgery.

(3) It is pointed out that the tubovalvular apparatus is applicable not only to the stomach but to any hollow viscus such as the bladder, cecum, colon, and jejunum.

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ENDOMETRIOSIS OF THE RECTUM AND SIGMOID

REVIEW OF THE LITERATURE AND CASE REPORT

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LARGELY because of its relative frequency and the peculiar physiologic syndrome which is so characteristic of this condition, endometriosis of the sigmoid and rectum is of unusual interest. Specifically, the term "endometriosis" is a misnomer, since it implies that the growth is a true blastoma, for which there is little supportive evidence. Disregarding, however, this fundamental meaning, the appellation has come to be commonly accepted as designating a tumor containing aberrant endometrium or tissue resembling endometrium, which responds to the same stimuli which affect normal endometrium. A combination of these endometriomata, better designated endometrial tumors,[31] constitutes a progressive disease referred to by Sampson[37] as endometriosis. Other terms applied to this condition are adenomyoma, adenomyosis[11] and peritonitis adenoides.[44]

Endometriosis occurs sufficiently frequently to be included among the more important benign lesions of the rectum and sigmoid. Sampson,[36] as reported in a recent article, found endometriosis 101 times in 474 gynecologic operations, and Green-Armytage[14] recorded an incidence of 8.9 per cent in a series of 1,000 consecutive surgical cases.

Endometriosis is almost exclusively a disease of women in the child-bearing age. The vast majority are seen between the thirtieth year and the menopause, although cases have been reported as early as 11,[40] and as late as 72.[11, 44] Most instances have occurred in white women. Various structures may be involved by this process, the more important of which are the ovaries, uterus, tubes, uterine ligaments, portions of the intestine such as the small bowel, appendix, cecum, sigmoid, and rectum, the peritoneum, omentum, bladder, the pouch of Douglas or rectovaginal septum, vagina, vulva, cervix, femoral and inguinal canals, umbilicus, and abdominal wall.

Probably the most plausible theory is that promulgated by Sampson,[38] known as "transtubal implantation." He contends that particles of endometrial tissue or tubal mucosa are detached and regurgitated with the menstrual blood to become implanted upon a site that is especially susceptible, such as the ovary or pelvic peritoneum. These implants tend to produce endometrial or "chocolate cysts" in the ovary. Ovarian endometriomata enlarge at the time of menstruation, fill with blood and rupture, so that their contents gravitate and implant themselves on adjacent structures, usually the posterior wall of the uterus and the anterior wall of the sigmoid, where they undergo secondary

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growth. Some investigators, however, argue against this hypothesis, in that it does not explain the presence of extraperitoneal implants such as those sometimes found in the rectovaginal septum, at the umbilicus and in the inguinal region. The serosal theory[18] is based upon the fact that the entire epithelium of the female genital tract is derived from the celomic mesothelium, so that, as a result of chronic irritation or some similar process, the serosa may undergo metaplasia or revert to its primitive function. Another theory is that endometriosis is the result of cellular metaplasia brought about by glandular dysfunction.[2] It has also been suggested[22, 46] that these tumors may develop in adult life from embryonic rests, from müllerian ducts or the wolffian body. Still another belief is that they are diverticula of endometrium which invade the wall of the uterus and adherent structures. Many other hypotheses have been offered, but may be dismissed as of no significant import.

Heidler[15] classifies this condition into endometriosis interna, representing the presence of heterotopic uterine glands in the deeper muscular layers of the uterine and tubal wall, and endometriosis externa. It is in this latter group that proctologists are especially interested, since involvement of the rectovaginal septum, rectum and sigmoid is the most frequent and important of all the external endometriomata.

Inflammatory reaction with fibrosis and adhesions is, according to MacLean,[26] characteristic. The most common site of endometrial implants is where the peritoneum is folded irregularly. Those of sufficient consequence to demand consideration are on the antimesenteric border of the sigmoid, at the attachments of the epiploic appendices and in the culdesac of Douglas. In the majority of cases these implants present themselves as one or more firm nodules varying in size from a buckshot to a cherry, and situated in the rectovaginal septum or culdesac of Douglas. Ordinarily they are slightly movable. They seldom attain large proportions, although instances have been reported where the growth was noted as a single, ill-defined mass which was of sufficient size to cause obstruction. One feature that is quite characteristic of endometriosis is that the mucosa of the rectum is rarely involved, as evidenced by its being freely movable over the tumor or tumors. This explains why ulceration seldom occurs and bleeding is infrequently mentioned.

Following involvement of the rectovaginal septum, the disease process may become diffuse, invade the muscular coat of the rectum and cause subsequent narrowing of the lumen. As pointed out by Oehlecker,[33] two forms of stenosis of the rectum and sigmoid have been encountered: (1) The tong-shaped constriction of the rectum together with a rectovaginal endometriosis; and (2) the rarer form which is fixed merely to the sigmoid flexure and has no relation to the genital organs.

Involvement of the sigmoid, according to Cullen,[9] is secondary to endometriosis of the rectovaginal septum. On the sigmoid the endometrial or adenomyxomatous tumors are of smaller size and occur as tarry cysts or raspberry-like elevations. A marked degree of puckering and scarring is noted which simulates that produced by a scirrhous carcinoma. Where stricture

exists it will be found hard and annular in type, yet usually the mucosa is uninvolved. It has been mentioned that the adhesions in patients with transplanted endometrial tissue are almost pathognomonic in that they are quite firm and rigid.[6] Like all endometrial tumors, they tend to enlarge slowly, are capable of invasion and metastasis, but are curable. It should be mentioned that malignancy has developed from an endometriosis situated in the rectovaginal septum.[40, 45] In one case metastasis to the lung was noted.[24]

On pathologic examination, sections show the presence of gland ducts extending beneath the mucosa into the muscular layer. The glands are lined with a single layer of typical endometrial epithelium, while outside the gland is a thin zone of endometrial stroma. Varying amounts of fibrous tissue are noted between the smooth muscle fibers. Ordinarily the mucosa is unchanged, although scattered areas of atrophy are noted.

The rectovaginal septum is the most common site of extra-abdominal endometriosis. In a series of 576 patients with adenomyoma affecting 689 organs, Masson[27] found the rectovaginal septum involved in 20 instances, and the sigmoid in 14. Polster[34] collected 90 cases and Keene[20] six, in a series of 118. Other instances of endometrial involvement of the rectovaginal septum, rectum and sigmoid have been reported.[4, 5, 7, 8, 10, 12, 13, 17, 19, 21, 23, 26, 28, 29, 30, 32, 33, 35, 42, 43, 47]

In a general way, it may be said that the symptoms of endometriosis are similar to those of chronic inflammation without the infection and suppuration.[3] Although they vary according to the size and extent of the growth, in almost every case they are increased in intensity at the time of menstruation. Usually, a history of progressive constipation over a period of months or years is obtained. In a few instances the constipation becomes so obstinate in type that when the patient seeks advice a partial obstruction is found. Pain in the rectum is more or less a constant feature and is described as a dull, aching discomfort, intensified by defecation and especially severe during the menstrual period.

Attention has been called to the fact that the symptoms tend to become worse and more prolonged each month, in those cases in which no treatment has been instituted.[29] Dyspareunia, dysuria and pain over the sacral region are not uncommon, but bleeding is infrequent. Diarrhea may occur, but is unusual. Sterility has been cited in 30 to 40 per cent of all cases observed. Dull abdominal pain in the left lower quadrant is usually present where the sigmoid is involved.

A history of rectal pain in a female during the years of ovarian activity that is constantly accentuated and is progressive at each menstrual period and which does not entail rectal bleeding, is highly suggestive of endometrial invasion of the rectum or rectovaginal septum. In the presence of the same symptoms, together with progressive constipation and left lower abdominal pain, involvement of the sigmoid must be suspected. Digital examination elicits one or more firm nodules in the septum that are usually exquisitely tender, not fixed, with the overlying mucosa movable and intact. Stricture of the sigmoid

due to endometrial implantation is usually not complete in its circumference. It is of annular type and hard, with much puckering, but the mucosa usually appears normal. Through the abdomen, sigmoidal endometriosis may be inferred by the presence of "chocolate cysts" adherent to its surface, which, when removed, reveal areas of puckering. A positive diagnosis can be made only by microscopic examination.

The treatment of endometriosis of the rectovaginal septum, rectum and sigmoid is essentially surgical, although radium or roentgenotherapy may be employed. Except where the rectal or sigmoidal growth is very large or a

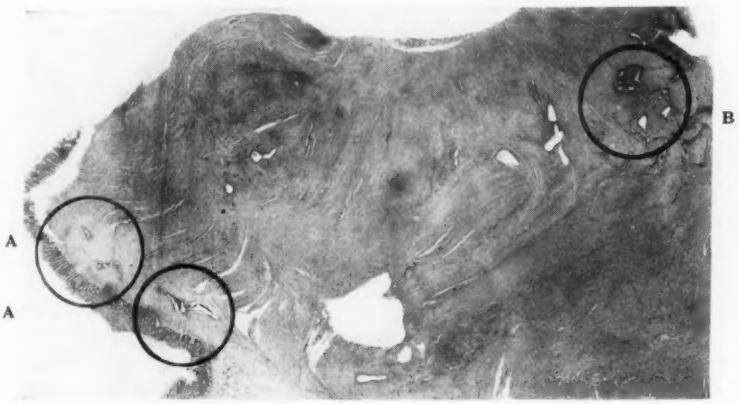

FIG. 1.—Endometriosis of the sigmoid. Low power ×10 showing general topography of the much thickened intestine with the normal mucosa along the lower border. Several groups of epithelial-lined spaces may be seen lying in the submucosa (A), and also deep in the thickened wall particularly in the upper portion of the section (B).

stricture is present, the safest and simplest procedure is to remove all ovarian tissue, following which the growth will regress and symptoms disappear. Lockyer[25] reports good results after total hysterectomy and bilateral oöphorectomy, with entire regression of the rectal tumor. Colostomy is indicated where the growth threatens to cause obstruction. Under such circumstances, an ideal procedure is to give the patient a temporary colostomy, perform bilateral ovariectomy, or restore the normal continuity of the bowel. Where the sigmoid is involved resection may be necessary, but removal of the tumor by an elliptic incision with transverse suture of the bowel and omental graft, as suggested by MacLean,[26] seems a very practical procedure. Instances have been recorded where endometriosis of the rectovaginal septum has disappeared under the influence of roentgen or radium therapy or a combination of the two.[1, 16, 29, 41]

Case Report.—A white female, age 36, was admitted to the hospital June 24, 1934, because of bleeding. The family and personal history were irrelevant, other than that the patient stated that she has had a straw colored vaginal discharge for three years. Examination showed multiple uterine fibroids and a left salpingo-oöphoritis to be present.

Laboratory Data.—Uranalysis: Sp. gr., 1.014, acid; albumin, negative; sugar, negative. Microscopic: Epithelia, mucous shreads, few pus cells. Blood examination: Leuko-

cytes, 4,400; hemoglobin, 12.2 Gm.; red blood cells, 3,650,000. Wassermann and Kahn, negative; blood sugar, 142 mg.

Operation.—June 25, 1934: The uterus was delivered through a median abdominal incision, the left infundibulopelvic ligament was ligated and cut, and the right and left broad ligaments were ligated and uterine arteries ligated. The uterus was amputated

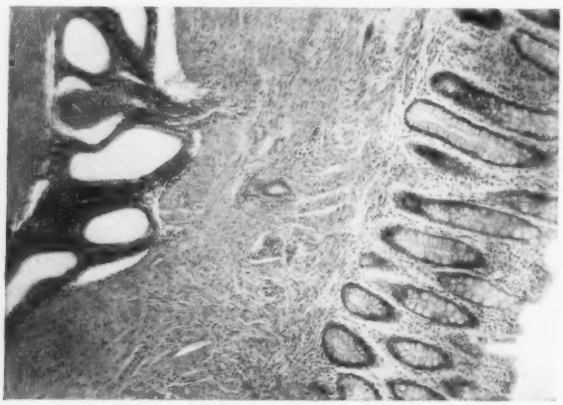

FIG. 2.—Area A. Endometriosis of the sigmoid. High power (×100) (A) showing normal mucosa and submucosa in which a portion of the endometrioma is seen below. Note the large glands lined with tall columnar epithelium surrounded by typical tunica propria similar to that in the uterus.

at the cervix and the cervical canal cauterized with phenol and alcohol. Raw areas were peritonealized with the bladder fold of peritoneum and the round ligaments sewed to the cervical stump. A Mikulicz procedure was employed in dealing with the involved sigmoid which was mobilized and brought out through a stab incision on the left side.

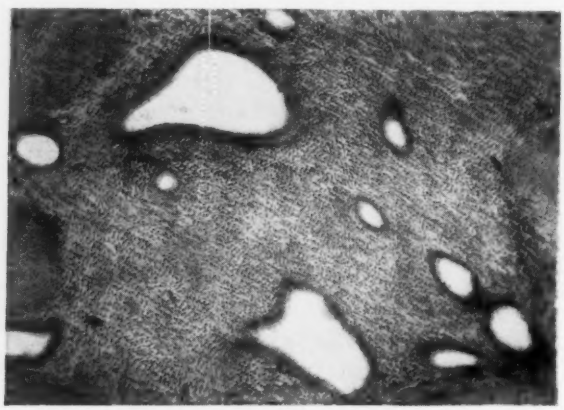

FIG. 3.—Area B. High power (×150) showing the endometrioma deep in the thickened intestinal wall. Note the typical tunica propria around the columnar lined glands.

The parietal peritoneum was sewed to the visceral peritoneum, and the fascia and skin of both wounds closed anatomically. The second stage operation was performed June 30, 1934. The patient was discharged August 23, 1934. General condition, good; wound on left side still draining.

Operative Findings.—Multiple fibroids of uterus; both tubes thickened and inflamed; left ovary sclerotic and cystic; appendix moderately inflamed; annular constricting mass

just above rectosigmoidal junction in the sigmoid; liver negative; no evidence of metastases.

Pathologic Examination.—Gross: "Specimen consists of two pieces of tissue. (A) An opened uterus 15 by 12 by 4 cm. showing many fibroids, each cut open in different directions, making it impossible to orient the specimen. Tubo-ovarian mass 7 by 5 by 2.5 cm. Tube definitely thickened. Ovary shows corpus luteum and small cystic spaces. *Microscopic* examination of the ovary shows a formation of endometrial tissue. Some fields are very typical. The whole history corresponds to that of endometrioma. (B) Specimen consists of a section of gut about 15 cm. in length, opened longitudinally. About the center of this section is a thickening of the wall which is not equal in all parts; in some places it is two to three times greater than in others. The thickened portion is very firm and is more or less rigid under the knife. *Microscopic* examination shows fair preservation of the normal condition of the mucosa but the rest of the wall is abnormal. There is marked thickening due to nonstriped muscle and fibrous tissue in which are glandular formations and interstitial tissue which on the whole is rather typical of endometrium. Some of these gland spaces are dilated and filled. Pathologic Diagnosis: Endometrioma of the sigmoid and ovary."

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EARLY CARDIAC DECOMPENSATION IN TRAUMATIC ARTERIOVENOUS ANEURYSMS*

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WE HAVE recently had the unusual experience of observing a traumatic arteriovenous aneurysm of the third portion of the left subclavian vessels which ended fatally on the fourth day following a stab wound in the supraclavicular fossa. The cause of death, as revealed by clinical observation and autopsy, was rapidly developing cardiac decompensation.

From studies of a large number of arteriovenous fistulae resulting from wounds received during the World War, and confirmed by further study of cases in civil life throughout the world, it has been established that, in addition to the local and peripheral symptoms of arteriovenous aneurysms, cardiovascular degenerative changes regularly follow the production of arteriovenous fistulae between vessels of large caliber.

It has been proven that the damage to the heart results from the shunting of large quantities of arterial blood into the venous channels through the fistulous opening, with consequent overfilling and dilatation of the right side of the heart. Serious cardiac symptoms are looked upon as late manifestations of the deleterious effects of arteriovenous aneurysms, hence, the early appearance of decompensation and the rapidly fatal outcome in the case herewith reported were surprising.

In discussing the case with Doctor Matas, he referred us to an article by Tixier and Arnulf,[1] entitled "Cardiac Accidents of Immediate Precocity in Traumatic Arteriovenous Aneurysms," who include, under this designation, the type of case in which severe cardiac symptoms appear within 15 days; reporting one personally observed instance, and giving abstracts of two others, one by Rocher and one by Stone.

A careful review of the literature failed to locate other similar instances; that is to say, reports of cases in which early cardiac decompensation was the outstanding clinical feature. The review did, however, reveal a case reported by Caraven,[2] where a combination of hematoma in the neck, dysphagia, dyspnea, and continuous thrill with systolic reinforcement, caused the author to operate on the fifth day, with immediately fatal result from hemorrhage and reflex disturbances attributed to the carotid sinus syndrome. Tixier and Arnulf suggest that: "One of the reasons why these early, immediate cardiac accidents are so rare is that in arteriovenous aneurysms which make very

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large communications the patient often requires immediate operation to prevent death from hemorrhage. In this stage it is difficult to assess which of the cardiac symptoms are due to traumatic shock and which to the establishment of the arteriovenous communication."

Likewise, too few cases of early cardiac decompensation have been reported to permit one to be dogmatic in the evaluation of dangerous symptoms. In general, it may be said that the symptoms of early cardiac decompensation do not differ from those which develop late. In those instances of which we have record, rapid pulse, dyspnea, cardiac murmurs and cardiac enlargement, together with rapid fall in blood pressure have been the outstanding symptoms.

Great technical difficulties and extremely dangerous consequences attend early operations upon arteriovenous aneurysms, especially in such locations as the groin and the root of the neck. Hence, when brought face-to-face with a cardiac accident of "immediate precocity," one must consider, on the one hand, the well recognized dangers of early interference, such as hemorrhage, infection and gangrene; and, on the other, the risk of death from rapid overfilling of the heart.

Reid[3] has summed up the advantages of delayed operation as follows:

"In some cases, hemorrhage, increasing hematoma, infection, and, *very rarely,* acute cardiac symptoms make it necessary to operate soon after the injury. When none of the foregoing complications makes operation imperative, delay presents the following advantages:

(1) A good collateral circulation develops which permits excision of the fistula without fear of gangrene.
(2) The injured vessels become thoroughly healed, making their dissection easier and safer.
(3) Infection is less likely to occur.
(4) Spontaneous healing may take place."

In operating in the early period, while the aneurysm is in the hematoma stage, conservative operations on the involved artery designed to preserve its lumen will prove extremely difficult and probably impossible, especially if the wound is in a location where proximal and distal control of the circulation is difficult to obtain. Multiple ligations on excision in this stage are likewise dangerous on account of the probability of gangrene of the part distal to the fistula.

Early cardiac decompensation has been observed so infrequently that no definite rules of procedure have been established. The dangers attending early radical operations have, however, stimulated thought as to safer methods which might be temporarily invoked to retard the progress of cardiac degeneration.

In arteriovenous fistulae experimentally produced, Holman and Stultz found that, in some instances, cardiac lesions failed to develop either early or late. This failure was attributed to the development of a thrombus in the

vein proximal to the fistula. Organization of the clot prevented the reflux of blood toward the vena cava and dilatation of the right heart did not occur.

Reasoning from this, it would appear that in the early stage, ligation of the vein proximal to the fistula might delay the development of cardiac decompensation until a favorable time for attempting radical cure of the arteriovenous aneurysm.

Proximal Ligation of the Vein.—Tixier and Arnulf[1] say: "Theoretically, if we accept the experimental work of Holman and Stultz, it might be possible to begin by the application of a ligature on the vein some distance above the fistula. The experiments of these authors show that by this simple procedure one may stop cardiac disorders. Later one may treat the arteriovenous aneurysm in the usual way." But, they add: "The lack of practical and clinical experience makes it impossible to judge the value of this procedure."

Doctor Matas,[4] likewise, comments favorably upon the possibilities of proximal ligation of the vein, and says: "Precocious cardiac complications are important prognostically and surgically because they compel an early intervention before the collateral circulation has had time to assert itself. They also modify the technic of the operation, because as yet the aneurysm has not emerged from the hematoma stage and the vessels and perivascular tissues have not fully recovered from the immediate effects of the trauma. I believe that cases of precocious cardiopathy bear out the rule that they are always associated with large direct fistulae in the great trunks near the heart or at the root of the limbs. Quoting the suggestion of Holman and Stultz, the ligation of the vein alone on the cardiac side of the fistula may suffice to stop the strain on the heart and permit a more complete operation at a later day when the collateral circulation is fully established."

Since cure of an arteriovenous fistula depends upon the complete and permanent closure of all abnormal communications between the arterial and venous systems, proximal ligation of the vein is not a curative measure and has no place in the early treatment of such a fistula if undertaken for the control of active bleeding or of slow hemorrhage manifested by an increasing hematoma.

If undertaken for the relief of impending cardiac disaster, the experimental work of Holman and Stultz leads one to hope that it may be helpful. This hope is strengthened in some degree by Stone's[5] clinical observation, that his patient's pulse showed immediate improvement when the vein was ligated; also by a case reported by Holman[6] in which "simple closure of the vein proximal to the fistula obliterated the thrill and caused the pulse to drop from between 108 and 112 to 84.

The ligation should be performed at a level some distance above the fistula —so as not to invade the region of the hematoma with its attendant difficulties and dangers. If proximal ligation is not followed by immediate improvement in heart action, the operator should be prepared, as Tixier and Arnulf have pointed out, to obliterate the fistula by multiple ligations or excision, leaving the question of peripheral gangrene for subsequent consideration.

Case Report.—Hillman Hospital, No. 110217: A colored, male laborer, age 29, married, was stabbed in the left supraclavicular fossa at 11 P.M., October 10, 1936, and was admitted to hospital at 2:30 A.M., October 11, 1936 in grave shock. Death occurred October 14, 1936, at 11 P.M.

Physical Examination revealed a stab wound over the outer third of the left clavicle. The patient was treated for shock, and the wound was sutured. Further examination revealed a pulsating swelling above and below the left clavicle which extended out towards the point of the shoulder. Over this area there was a marked thrill and a continuous bruit with systolic accentuation. The bruit was transmitted down the arm, over the upper aspect of the chest, anteriorly and posteriorly, and along the side of the neck.

Examination of the heart: Apex beat forceful. It was visible in the fifth interspace at the nipple, and palpable 1 cm. to the left of the nipple in the fifth interspace. Systolic murmurs were heard at the apex and at the second right and left interspaces. There was an occasional extra systole. The right radial pulse was much stronger than the left. Blood pressure, right 154/54; left 114/54.

The rest of the physical examination was essentially negative. His previous history was irrelevant. He denied luetic infection but had had two attacks of gonorrhea. He smoked and used alcohol in moderation. He had worked regularly up to the time of injury.

Laboratory Data.—Urine, 1,022, acid, albumen 400 mg., no sugar, no pus, no blood, no casts. Blood, hemoglobin 63 per cent, red blood corpuscles 3,230,000, leukocytes, 10,900, large and small lymphocytes 25 per cent, polymorphonuclear leukocytes 75 per cent. Kline test, plus 4.

TABLE I

DAILY RANGE OF TEMPERATURE, PULSE AND BLOOD PRESSURE

Blood Pressure	Right	Left	Pulse	A.M.	P.M.
Oct. 11	154/54	114/54		100	80
13	114/48	94/50		100	100
14	98/50	82/50		100	100
Temperature:			Oct. 11	97°	99°
			12	99°	99°
			13	99°	100°
			14	99.4°	99°

Respirations 20–26 throughout the illness.

Roentgenologic examination of the chest.—October 13, 1936: "Both lung fields clear. The outline of the heart is rather unusual in that it is triangular in shape and has a straight left border" (Fig. 1).

Clinical Course.—When admitted three and one-half hours after the injury, the patient was in shock. There were marked signs of cardiac impairment which, by negative autopsy findings, were thought not to have antedated the injury. Blood examination showed 3,230,000 red cells and 63 per cent hemoglobin; hence it was concluded that the shock was out of proportion to the amount of blood lost before his admission. There was no loss of blood, either internally or externally, after he reached the hospital.

Fluoroscopic and roentgenologic examinations of the chest, made on the third day, revealed an enlarged heart, but there was no evidence of hydrothorax or hemothorax. A teleroentgenogram was contemplated but death took place before this could be made.

Thrill, bruit, and hemic murmurs persisted. The great disparity in blood pressure on the two sides, and the promptness with which the left radial pulse lost strength and volume, demonstrated the rapidity of the return of blood to the heart through the fistula.

During the four days which preceded his death, there was complaint of constant pain in the left chest and of dyspnea; there was a steady fall in systolic and diastolic blood pressure; the pulse rate ranged between 100 and 120; albumen appeared in the urine; the

respirations were shallow and ranged between 20 and 26 per minute. At autopsy a right pleural effusion, approximately 400 cc. in amount, was found. There was no evidence of this on the third day, when the roentgenograms were made, and its presence at autopsy indicated that it had developed within the last 36 hours of his life.

After the initial shock was overcome, the treatment consisted of rest, sedatives, and supportive measures for the heart; none of which were effectual.

Autopsy.—This was performed by Dr. G. S. Graham upon the embalmed body, three days after death. Externally, the only notable abnormality is a recently sutured, penetrating wound just above the outer third of the left clavicle. It is about 2 cm. in length, its margins clean and in an early stage of healing. About 400 cc. of clear serous fluid are

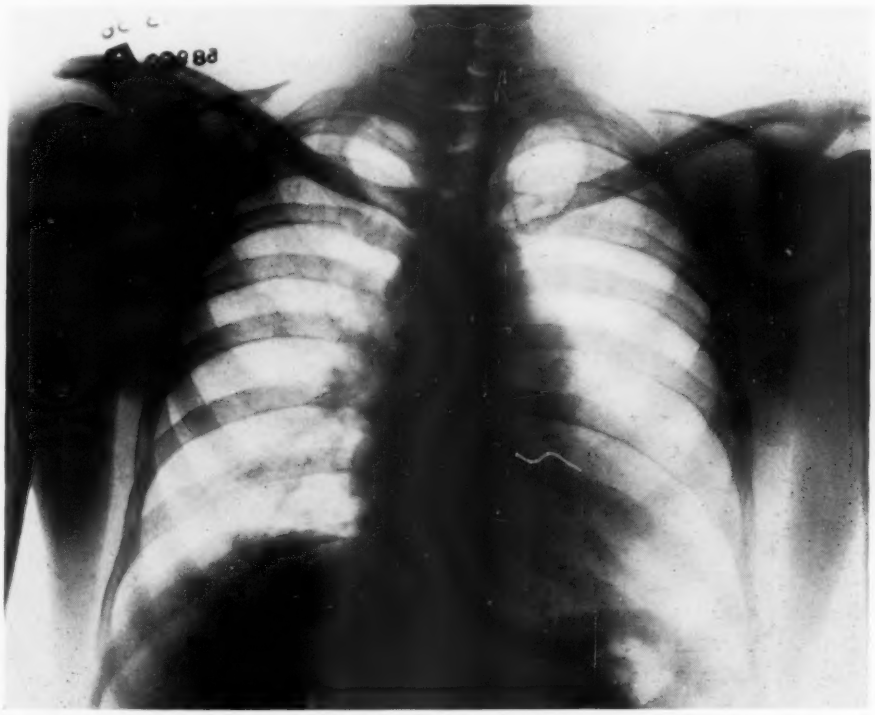

FIG. 1.—Roentgenogram of the chest taken 36 hours before death. Note the enlarged triangular outline of the heart and the absence of any shadow denoting fluid in the pleural cavity.

present in the right pleural cavity. No gross changes are seen in the organs below the diaphragm.

The heart and thoracic aorta together with the great vessels of the neck and the entire left subclavian artery and vein were removed en masse. The tissues beneath and about the wound are suffused with blood, which extends downward and outward in and about the pectoral muscle mass to the axillary margin, and mesially in the muscle planes and connective tissue about half way to the sternal margin. It also extended beneath the parietal pleura of the anterior chest wall to about the third rib. The wound tract perforates the subclavian vein in its anterior and in its postero-inferior wall and opens the adjacent wall of the subclavian artery through an oval aperture measuring 4x3 Mm. The anterior wound in the vein wall measures 5x6 Mm. and is located 13 cm. from the junction of the vein with the left innominate (Fig. 2). A probe passes through it into the lumen of the artery (Fig. 3). The posterior wound of the vein wall is larger. It opens outward into a cavity in the apposed fibromuscular tissue that reaches a diameter of about 3.5 cm. Its inner surface

is irregularly sacculated and trabeculated. The cavity contains fresh and clotted blood and adherent to the wall are patches of laminated clot resembling those of a true aneurysm. There is slight fusiform enlargement of the vein proximal to the wound. The dilated segment is about 4.5 cm. long and its wall is definitely thinned. The diameter reaches 2 cm. as compared with a diameter of 1.2 cm. at the wound level.

The heart is slightly enlarged. It weighs 406 Gm. The epicardium is smooth. The myocardium is completely fixed by the embalming fluid, and its gross characters are obscured. No scars nor other gross changes can be made out. The valve measurements are: Tricuspid 14.5 cm., pulmonary 8.3 cm., mitral 11.5 cm., aortic 8.0 cm.

The wall of the right ventricle is 0.3 cm. thick, the left ventricle 1.8 cm. The right auricle is definitely enlarged, the other chambers are of normal size. The valves and endocardium are smooth. In the ascending arch of the aorta there is a large patch of

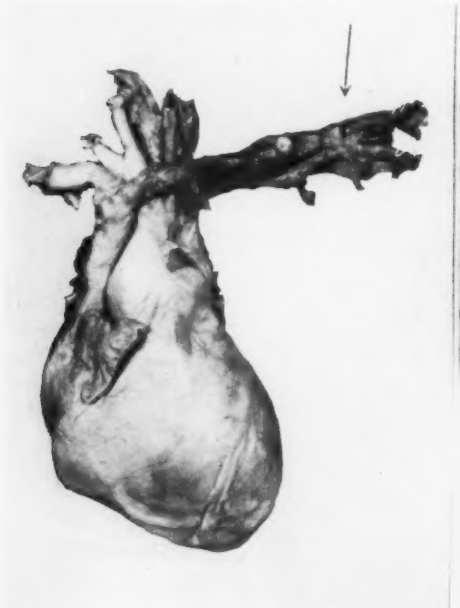

FIG. 2.—Photograph of the heart and left subclavian vessels. Arrow points to the wound in the subclavian vein.

FIG. 3.—Left subclavian artery incised showing the fistulous communication with the subclavian vein.

thickening and scarring that begins at the valve level and encircles the wall in about three-fourths its circumference. The process involves two of the aortic valve commissures where it produces a widening and thickening of the attachments. The lesion envelops the orifice of the left coronary artery and narrows it. The coronaries are otherwise free of gross changes.

Anatomic Diagnosis.—Stab wound above left clavicle producing traumatic arteriovenous fistula of left subclavian artery and vein. False aneurysm at wound site. Dilatation of right auricle of heart. Slight cardiac hypertrophy. Luetic aortitis.

Sections taken at the wound site show, in the vessel walls, little leukocytic reaction to the injury. Proliferating fibroblasts are gathering in the wall of the false aneurysm and a few lymphocytes are present here. A laminated clot is already being built up within the aneurysmal cavity.

In the heart, sections from the right auricle and ventricle show no recognizable changes in the musculature or coverings. A block from the left ventricle shows, in the subendocardial zone, a layer of early necrosis of the muscle fibers with partial failure of the stain-

ing reaction of the nuclei and cytoplasm. In the affected muscle and especially along its margins there is an infiltration of leukocytes; predominant among them are polymorphonuclears. The small vessels are engorged and there is occasional suggestion of early thrombus formation. Outside this zone the muscle is of normal appearance and the blood vessels are free of lesions.

The lung shows generalized engorgement of the capillaries of the alveolar walls, and a coagulated serous fluid filling most of the alveolar spaces. Large numbers of "heart failure cells" are present. There are scattered, minute areas of early leukocytic exudate.

There is moderate venous engorgement in liver, spleen and kidney, otherwise there are no noteworthy changes found in the remaining organs.

ABSTRACT OF REPORTED CASES

(1) Tixier and Arnulf.[1]—Traumatic arteriovenous aneurysm of right femoral vessels in Scarpa's triangle following gunshot wound, November 16, 1933.

Marked cardiac decompensation on fifth day. Quadruple ligations and excision on ninth day. Prompt relief of cardiac decompensation. Impairment of peripheral circulation followed, with edema, superficial gangrenous areas, and contracture of foot in equinus to approximately 120 degrees. These complications necessitated lumbar sympathectomy and tenotomy of the tendo Achillis in February and August, 1935, respectively, and gradual restoration of function.

(2) Rocher, Surgical Society of Paris, 1919.—Aorta-caval arteriovenous aneurysm from gunshot wound received in action 15 days before admission to hospital. The patient was dyspneic, and there was congestion at both lung bases. The pulse was 120. There was a large diffuse mass behind the liver, over which could be detected a thrill, and a bruit which could be heard from the groin to the neck. Hematuria was present. A few days after admission there occurred a great fall in diastolic blood pressure. Diagnosis of arteriovenous aneurysm between the aorta and renal vein was made because of the hematuria. No operation was to be considered on account of the inaccessibility of the lesion and the desperate condition of the patient. He died at the end of three months from progressive heart failure. Autopsy showed that the arteriovenous communication was between the aorta and the vena cava.

(3) Stone.[5]—The patient had received a stab wound of the femoral vessels in left goin. He was seen the day following the injury. There was a large hematoma. The pulse rate was 120 and scarcely perceptible at the wrist. The patient was in a critical condition and immediate intervention was imperative. The artery and vein were exposed above the point of injury. Immediate improvement followed ligation of the vein, and the pulse dropped to 100 upon ligation of the artery. Improvement was rapid and the patient made a complete recovery.

(4) Caraven.[2]—Carotid-jugular fistula. A man was shot through the neck five days previous to admission. He was suffering from dysphagia and dyspnea; there was an hematoma at the anterior edge of the left sternomastoid muscle over which a thrill and bruit with systolic accentuations could be heard. In addition to the wounded vessels, the respiratory and digestive tracts had been injured. The patient was operated upon at once. Death occurred on the table from hemorrhage and from cardiac symptoms which the author attributed to carotid sinus reflexes.

SUMMARY.—The treatment employed and the results obtained in the five cases herein discussed were as follows:

Our own case, left subclavian vessels; died on the fourth day without surgical interference.

Caraven's[2] patient, carotid-jugular vessels complicated by injury to the trachea and esophagus; operation on fifth day; died on the table from hemorrhage and carotid sinus reflexes.

Rocher's patient, aorta-caval fistula; died without surgical intervention at the end of three months.

Tixier and Arnulf's[1] patient, femoral vessels at the groin; multiple ligations and excision on ninth day; cardiac decompensation arrested; prolonged

disability from impairment of the peripheral circulation which required secondary lumbar sympathectomy and tenotomy for relief.

Stone's[5] patient, femoral vessels at the groin; multiple ligations on second day; complete recovery.

CONCLUSIONS

In the imperfect state of our knowledge of this serious condition, due to the limited number of observations, it behooves us to give careful attention to the behavior of the heart in all cases of traumatic arteriovenous aneurysm of the larger vessels, and to exercise extreme conservatism in undertaking early operation.

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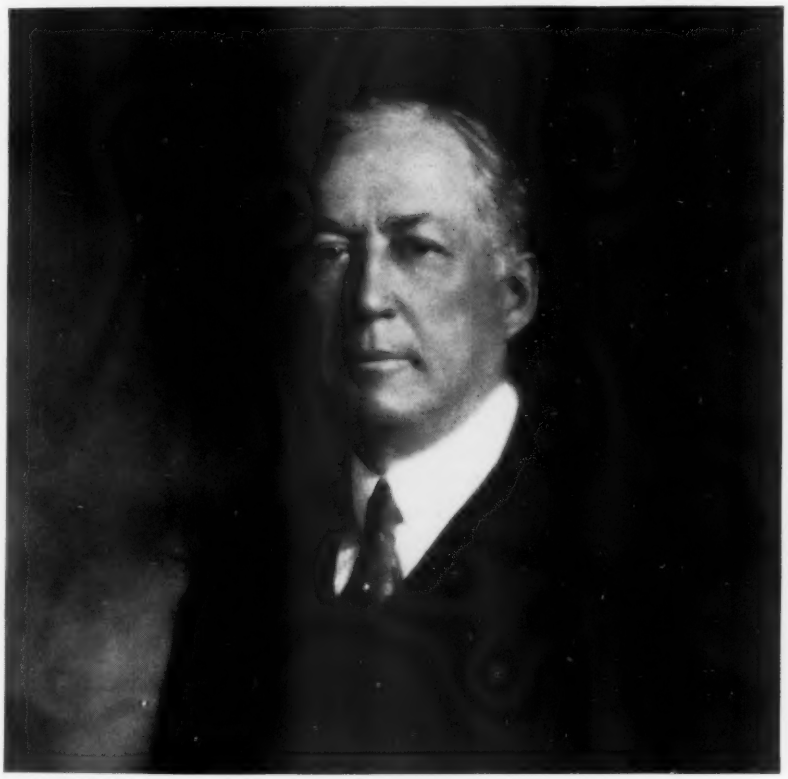
MEMOIR

DANIEL FISKE JONES

1868–1937

DOCTOR JONES was born in Minneapolis, Minn., June 2, 1868, and died in Boston September 11, 1937. He received his preliminary education in the Minneapolis public schools and entered Harvard University at the age of 20, being graduated from this institution with an A.B. degree, in 1892, and an M.D. degree, in 1896. Following his surgical internship in the Massachusetts



DANIEL FISKE JONES, M.D.

General Hospital, he became associated with Dr. Maurice Howe Richardson as his private assistant. His long contact with Doctor Richardson was very pleasant as well as one which furnished ample opportunity to develop his surgical knowledge and skill.

In 1903, he was made surgeon to Out Patient in the Massachusetts General Hospital, and to this institution he was devoted throughout his active career,

gradually rising to chief of the East Surgical Service, in 1925, which position he held until the retirement age of 60. At the same time that he received this appointment to the Massachusetts General Hospital, he became an associate in surgery in the Harvard Medical School, which position he held until 1932.

Doctor Jones was also interested in the New England Deaconess Hospital and was a member of the staff of that institution from 1898 until his death. He was made surgeon of this institution, in 1923, and chief surgeon of the Palmer Memorial Hospital, associated with the Deaconess, in 1927.

His war service started in 1916 when he went to France as Surgeon-in-Chief of the Harvard Surgical Unit in charge of the Twenty-second General Hospital of the British Engineering Forces. In July, 1918, he became a major in the Medical Corps of the United States Army and went overseas a second time in October of that year. He was discharged May 21, 1919, with the rank of Lieutenant-Colonel.

Doctor Jones carried on one of the most extensive private practices of any individual that we know. He never refused any call on his time. Regardless of the status of the patient or his location, he was ever ready and willing to give his services—often at times when he should have been resting. Few men have worked harder at their jobs than he. Fortunately, he had a very strong physique and this made it possible for a great many sufferers to benefit through his endeavors. He had unusual ability in diagnosing obscure lesions. Being endowed with the type of mind that allowed him to combine the history of the patient, the laboratory data, and the physical findings, he arrived at the logical conclusion almost infallibly. Technically, he was not spectacular but he had proper respect for tissue, a definite understanding of how much or how little an individual patient could stand, and his results were far above the average. This made him an excellent teacher—not so much from the standpoint of the undergraduate as from that of the house officer and resident. One could rarely find him operating without as many men in the stands as could be free at the moment, hoping to add to their own fund of knowledge from this great master. He was particularly interested in surgery of the large bowel and developed the surgery of rectal cancer in an exceedingly competent and satisfactory manner. His efforts in educating the profession in New England in the early diagnosis of cancer of the rectum are well substantiated when one considers that the operability of this lesion in the 25 years during which he was interested in it has increased from approximately 30 per cent to approximately 70 per cent. Also, largely through his experience and teaching, the mortality from this operation has been reduced to approximately 10 per cent in the Massachusetts General Hospital.

His chief recreation was the "big woods" and fishing, which he thoroughly enjoyed. He traveled considerably but when at home his first love was his work. He was never so happy as when a difficult surgical problem was being dealt with, and one must admit that his hobby was surgery. This did not prevent him from having a host of friends among both the profession and the laity.

Doctor Jones was a member of the American Surgical Association and was its president in 1933. He also belonged to the Southern Surgical Association, the Society of Clinical Surgery, the Interurban Surgical Association, the New England Surgical Society, the American College of Surgeons, the Boston Surgical Society, and the Massachusetts Medical Society.

He was a Regent of the American College of Surgeons from 1921 to 1923, and a member of the Board of Overseers of Harvard College from 1932 until his death. He was on the Board of Trustees of the Boston Medical Library.

In 1899, Doctor Jones married Mary Haughton Richardson of Brookline, Mass. Mrs. Jones and three children survive him. One cannot help mentioning the perfect sympathy which his devoted wife had toward his work and the completely unselfish attitude which she assumed in this matter.

We will sorely miss this devoted friend, this master surgeon, and this able teacher. We are grateful for his long and useful life.

ARTHUR W. ALLEN

BOOKS RECEIVED

The receipt of books for review is hereby acknowledged. This statement shall be regarded as sufficient acknowledgment of the courtesy of the publishers. Selections will be made for review predicated upon the interests of the readers of the ANNALS OF SURGERY and as space permits.

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